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Errata

Vol. 9, *No.* 3, *March* 1940: (1) Editorial Article, p. 106, first quotation: *For* "And Isaac interested" *read* "And Isaac intreated"; *For* "the Lord was interested" *read* "the Lord was intreated". (2) Contribution entitled "Calcium Utilisation from Green Leafy Vegetables", p. 124, second column, first line: *For* "the skim milk" *read* 'its"; (3) Contribution entitled, "Kostanecki Acylation of Orcacetophenone", p. 118, lines 13 and 14: *For* "Orcacetophenone and its monomethyl ether on benzoylation gave", *read* "Orcacetophenone on benzoylation gave"; (4) Contribution entitled, "Asynapsis in Chilli (*Capsicum annuum*, L.)", p. 126, para 1, first line: *For* "meotic" *read* "meiotic"; Fifth line: *For* "such as" *read* "in". Para 2, line 9: *For* "(Fig. 1)" *read* "(Fig. 2)"; line 11: *For* "(Fig. 2)" *read* "(Fig. 1)". P. 127: It must be noted that Figs. 6, 7 and 8 are reduced to 4/5 and Fig. 9 to ½ the original; P. 128: at the bottom of the note *for* "Imperial Agriculture Research" *read* "Imperial Agricultural Research".

Vol. 9, *No.* 9, *September* 1940: Supplement: Article entitled, "His Highness Maharaja Sri Jaya Chamaraja Wadiyar Bahadur," p. ii, column 2, third line, *for* "reigns" *read* "reins".

Vol. 9, *No.* 10, *October* 1940: Review article entitled, "Excavations at Harappa", para 5, line 6, *for* "Mr. Vats" *read* "Mr. Mohammad Sana Ullah".

Vol. 9, *No.* 11, *November* 1940: Review article entitled, "Science in War", *for* "Price 6*sh.*" *read* "Price 6d.".

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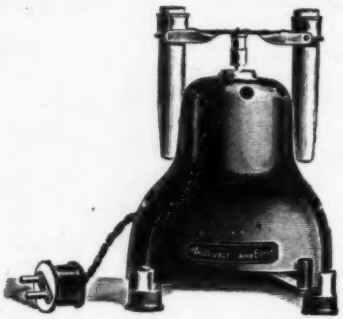

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INDUSTRIAL MUSEUMS

THE meaning of the word 'Museum' is 'temple of the Muses'. It denoted different things at different periods in history. Even libraries and places of literary study were once called 'museums'. The conception that it is a depository of curiosities and rarities is comparatively of recent origin. In Western countries, the period of explorations created and encouraged a great thirst in peoples' minds for the collection of beautiful and interesting objects from several corners of the world newly opened to them. One finds in the 17th century European princes, aristocrats, scholars and even clergymen keeping 'museums' as a mark of dignity and cultural superiority. During the 19th century the museum was no longer considered merely as a means of gratification to the aristocracy of rank and scholarship, but it was raised to the status of an important public institution meant to serve as a laboratory of research and an educational centre.

To-day every European country possesses museums which originated in the art collections of mediæval princes and nobles. Finding the enormous educational possibilities of the museum various governments have been following a consistent policy of encouraging, equipping and popularising the institution. The study of natural science was greatly facilitated by the collections of stones, plants, insects, animals, birds, etc., and the art pieces gathered and exhibited in the museum roused the creative spirit of European artists. The rapid increase in the number of museums in Europe and elsewhere bear ample testimony to their importance in modern society. It suggests

that a country that aspires to progress on modern lines will find in the museum not an instrument of negligible value but an institution necessary for the education and the enlightenment of the masses and the classes.

It is not an accident that the greater the industrialisation in a country, the more numerous are the museums organised. There are about 8,000 museums in the world to-day and about 6,500 of them are concentrated in the highly industrialised countries of Europe and in the U.S.A. The leading countries in industrial and scientific progress,—the United States and Germany—can boast of more than 1,500 museums each, while France and Britain maintain 1,200. Italy has 400 to her credit and the giant engine of Soviet educational propaganda makes use of 200 well-kept museums for the propagation of the principles of communism and for the instruction in the industrial arts. Imperial Japan is quick in imitating the West and she has rapidly developed 160 museums while the vast area of yellow China has only about 100 institutions. Taking the British Empire into consideration we find the figures are as follows:—Australia and New Zealand 160; South Africa 60; Canada 125. Against the background of European countries and the British Empire the fact that India possesses only 105 museums must be a matter of regret for those who are interested in the all-round progress of our country.

Museums are of different types: art museums, science museums, etc. But India requires institutions specially devoted to the dissemination of knowledge in crafts and industries, both of the past and the present. In other words, India requires the 'Industrial Museum' more than any other type. She is on the threshhold of industrial advancement and the industrialisation of the country calls for a very large number of museums where the average citizen may learn, at first hand, about the growth and possibilities of village industries and crafts, new mechanical devices, new products, etc. He must see in the exhibits before him the past glory of our industries, and their present decay. He will then feel it his duty to encourage national industries. His pride in our industrial past would generate a noble feeling of well-directed patriotism without which democracy is impossible. The Industrial Museum is a depository, not only of the past industries, but also of the present growing industries and crafts. It must stimulate the curiosity of the public and awaken the average man so that he may know, and wish to know, more about the world in which he lives. The visitor should be impressed by means of exhibits and explanations how our own country produces a hundred good things which he blindly purchases from the foreigner, and how the dying and dead crafts can be resuscitated only if he is an intelligent and patriotic purchaser in the market. I am sure that there are thousands of educated people who purchase foreign products just because they are not aware of the progress in indigenous manufacture. If those men and women are attracted to the industrial museum, is there any doubt that the cause of *Swadeshi* would be well served? Many do not know the processes in the manufacture of articles they buy and use. A visit to the museum will enlighten them and increase the craving for further development. In recent years we hear politicians raising the slogan, "Go back to villages". How useful would industrial museums be in the attempt at educating the artisans and the peasants of the villages in

the simple crafts and rural industries so that their standard of living may be slowly, but surely, raised! The Wardha Scheme of Education aims at giving our school-boys instruction in useful crafts and industries. Gandhiji's scheme may be well served by the institution of industrial museums all over our country, in important centres, so that school children may be taken to the museums regularly—as they do in the United States of America and in Soviet Russia—and there taught the principles and processes of the manufacture of the articles in daily use.

At present, for a population of 350 millions spread over two million square miles, we have only 105 museums and very few of them are specially devoted to the industries. Even many of our cities are without any industrial museums. Recently there is a healthy trend towards the establishment of industrial museums in our important cities. The part played by the Congress and other national organisations in establishing technological museums deserves our praise. But one should remember that in the absence of generous help from the Government, the responsibility of encouraging industrial museums rests largely with the public. We hope that our Universities, municipalities and other public bodies would come forward in organising well-equipped museums for the rapid industrial, educational and cultural progress of India.

B. V. NARAYANASWAMY.

'ASCU' WOOD PRESERVATIVE

"PENDING clarification of these and other obscure points the Forest Research Institute has decided to withdraw its publication, 'Ascu'—A wood preservative, *Indian Forest Records* (New Series), *Utilisation*, Vol. I, No. 6, and to postpone its re-issue in a revised form until the results of further research and adequate service tests are available." This announcement is contained in a note issued by the Forest Research Institute, Dehra Dun, under the signature of Mr. L. Mason, President of the Institute.

This very unusual procedure of formally withdrawing a scientific publication originally issued under official authority raises a number of points which are not rendered any simpler by the fact that the process in question is covered by a patent which has been commercially exploited in India and, it is learnt is under active consideration even outside. When reviewing the publication *'Ascu'—A Wood Preservative* (*Curr. Sci.*, 7, No. 3, p. 141), attention was drawn, in particular to two facts; first on the mass of data and a century of experience which the older creosote and zinc chloride processes had behind them and which 'Ascu' on account of its infancy could not possibly have, and secondly, on the lack of a bibliography of relevant literature in the publication. And although the Foreword to the *Record*, explicitly warned that it was "too early to pronounce a definite or final opinion on its merits or limitations", it must be confessed that this withdrawal was entirely unexpected. The Forest Research Institute took on itself a heavy responsibility in originally recommending the process and sponsoring the official publication and its responsibility is no less onerous in withdrawing its official *imprimatur* now after more than six years. It is not merely the future of a particular process that is involved now; it is the future of a pioneer industry still in the nascent stage. Public acceptance in India of wood preservation processes as such, is definitely hampered by these unfortunate developments relating to 'Ascu'.

ROBERT ANDREWS MILLIKAN

(Chairman of the Executive Council of California Institute of Technology and Director of the Norman Bridge Laboratory)

ON March 22nd, 1868, Robert Andrews Millikan was born in a small town of Illinois. After graduation from the local high school he went to Oberlin College in Ohio, where in 1893 he received the Bachelor's Degree, and two years later the Master's Degree. He then went to Columbia University in New York City for his doctorate in Physics. Before beginning a brilliant career in Chicago University he went abroad for a year's further study in Berlin and Göttingen.

In addition to routine teaching during his twenty-five years in Chicago, Prof. Millikan found time and energy for an immense amount of fruitful research and writing. He found time also for popular lectures and a great variety of campus and community service. To him must go much credit for his part in the movement which is helping to educate the general public to the significance of modern science. His text-books in elementary physics, in particular, have greatly contributed to a new conception of science teaching. They help both student and teacher to see physics as a living, growing science intimately related to our everyday life.

Professor Millikan's intellectual curiosity and contagious enthusiasm are everywhere evident in his lectures and writings. His ingenious speculations, based on scientific data, catch the imagination and hold the interest of his readers, and whet their appetites for more information. It will be a great day for humanity when the average student of the sciences—and of other subjects—will be caught and drawn on in his studies by an irresistible curiosity rather than be driven by the corrosive fear of impending examinations. In order to help bring about the new day we need many teachers and writers of text-books (if indeed texts are to survive!) such as Professor Millikan who, by their own keen insight and their vigorous, friendly personalities, will inspire students to develop the best that is in them.

In recognition of Professor Millikan's notable contributions to the advancement of knowledge, he has been awarded many honorary degrees by the great Universities of Europe and America. Gold Medals have been showered on him and many learned societies have honoured themselves and him by enrolling him on their membership lists.

Dr. Millikan's beautiful determination of the charge on the electron won for him in 1923 the much-coveted Nobel Prize and will long remain an outstanding example of human ingenuity. The refined simplicity of theory and laboratory technique enhance the elegance of this classic work. Professor Millikan once said, "If the Nobel Prize had not been awarded to Albert Einstein for his work on the Photo-Electric Effect, it might well have been given to him for any one of four or five other outstanding contributions". Similarly it may be said that if this rare Prize had not been given to Doctor Millikan for measuring the charge on an electron it might have been awarded to him for his own beautiful photo-electric measurements, or for his pioneering work in spectroscopy or the cosmic rays.

The titles of Professor Millikan's books indicate that in addition to his work in classroom and laboratory, he has found time to consider the significance of science for human welfare and to direct the attention of his readers to their responsibility for the right use of the new power which science is so rapidly conferring on immature men.

At the age of seventy-two (nearly), Prof. Millikan is not only the active head of one of the world's foremost schools of technology and director of its physics laboratory, but also finds time for committee work of international importance, and for continuous intensive research in his own special field of cosmic radiation. At the present time he, with Mrs. Millikan and two able collaborators, Dr. Victor Neher and Dr. W. H. Pickering, is in India collecting data on cosmic ray intensities in the stratosphere.

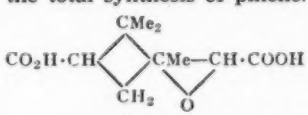
J. M. BENADE.

PROFESSOR L. RUZICKA

THE work of Ruzicka can be broadly divided into three distinct groups: (*a*) his earlier work on quinatoxins, (*b*) his researches on the higher carbon ring compounds, and (*c*) his extensive researches on the chemistry of terpenes and allied bodies, including the sterols and resin acids. In this short article an attempt will be made to present an account of his work in a connected manner so that a proper perspective could be formed of his brilliant achievements.

Researches on terpenes and allies.—Ruzicka's first published paper[1] was with Staudinger in 1911, when he published some work on the ketenes. After this, there is a long gap and his next paper[2] was published in 1918 in which he described a complete synthesis of fenchone. The conversion of borneol into camphene has been explained hitherto in two ways by the assumption, on the one hand of a tricyclene and on the other, of a substance containing bivalent carbon. From the first, camphene would result by the fission of the trimethylene ring. Whilst in the case of a secondary alcohol such as borneol the above two explanations are possible, the Wagner rearrangement of a tertiary alcohol is possible only through a tricyclene. Methyl borneol and methyl fenchyl alcohol both give on dehydration the same mixture of hydrocarbons from which both camphor and fenchone are obtained on ozonisation. The reaction can be explained only if a common tricyclene be assumed to be formed from both tertiary alcohols.[3]

In 1919, a synthesis of linalool[4] was effected by treating the sodio derivative of methyl heptenone (formed with sodamide) with acetylene in dry ether. The dehydro linalool formed was ingeneously reduced with sodium and traces of water to linalool. In 1921, considerable progress[5] was made towards the total synthesis of pinene. Ethyl



I

γ-pinonate was condensed with ethyl chloroacetate to a glycidic ester from which the acid (I) was prepared. The latter was converted by heating *in vacuo* to the semi-aldehyde of homopinocamphoric acid. The Dickemann reaction on the ester gave γ-pinocamphone. Since *α*-pinene has already been obtained from the corresponding alcohol pinocampheol, therefore a partial synthesis of pinene was claimed.

In 1922 began a series of investigations on the dehydrogenation of terpenes with sulphur which paved the way for the final elucidation of structure of many members of this group and the related substances. A substantial advance in our knowledge of the sesqui-terpenes[6] resulted from the investigation of the nature of aromatic substances produced by heating them with sulphur. The dehydrogenation of cadinene, calamenol, zingiberene and the sesqui-terpene from Javanese citronella oil gave one and the same hydrocarbon, $C_{15}H_{18}$, termed cadalene which was proved by synthesis to be 1 : 6-dimethyl-4-isopropyl naphthalene.

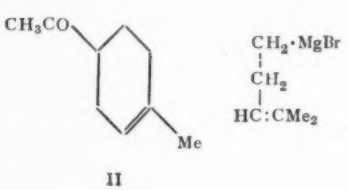
A complete synthesis of nerolidol and farnesol[7] was occomplished by condensing *αβ*-dihydro-ψ-ionone, $Me_2C:CH.CH_2.CH_2.CMe:CH.CH_2.CH_2.COCH_3$, with acetylene, as in the case of the synthesis of linalool, and dehydro dl-nerolidol was obtained. The reduction of the latter with sodium in moist ether gave dl-nerolidol [$Me_2C = CH.CH_2.CH_2CMe = CH.CH_2 - CH_2 - CMe(OH) - CH = CH_2$] which passed into farnesol with acetic anhydride. The formation of eudalene from eudesmol and selinene, established that in the biogenesis of the terpenes the three isoprene residues joined end to end (as in farnesol) can be coiled up to produce the cadinene frame work and also may coil up in two other alternative manners, of which eudalene represents one type. When farnesene is treated with acetic acid containing a little sulphuric acid,[8] it is converted into the acetate of *α*-bisabolol; the alcohol on treatment with hydrogen chloride gives a trihydrochloride identical with natural bisabolene from oil of opopanax. Since farnesene[7] had been synthesised from geranyl chloride *via* dihydro-ψ-ionone and nerolidol, hence a complete synthesis of bisabolene was accomplished.

The structure of zingiberene was investigated and the carbon skeleton of zingiberene was proved to be the same as that of bisabolene.

The constitution of santonin was investigated by Clemo and Haworth who synthesised desmotroposantonin and more or less

settled its constitution but proof was still needed for the position of the methyl group. Ruzicka dehydrogenated with selenium the Clemmensen reduction product of tetrahydro-santonin and isolated 1-methyl-7-ethyl-naphthalene[10] which thus placed it in the eudesmol (selinene) group of terpenes.

The synthesis[12] of bisabolol and bosabolene was accomplished as follows: The ketone II, obtained by ozonolysis of β-terpeneol was condensed with the Grignard reagent from ε-bromo-β-methyl Δ^2-pentene

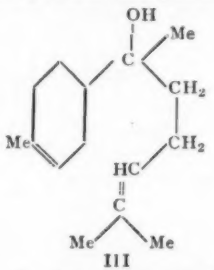


II

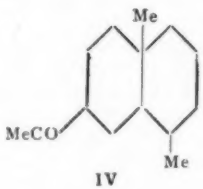
giving bisabolol III. This synthesis removed all doubts as to the position of the double bond. The conversion of the dehydration product of dihydro-eudesmol by ozonolysis into acetyl dimethyl decalin of the structure IV proved the position of the hydroxy group in eudesmol.

The oxidation of abietic acid with excess of permanganate gives two acids,[13] $C_{11}H_{16}O_6$ and $C_{12}H_{18}O_6$. The former is dehydrogenated by selenium to *m*-xylene and the latter to 1 : 2 : 3 trimethyl benzene. From this the conclusion was drawn that the methyl group which is lost in the dehydrogenation of abietic acid to retene occupies the 12 and not the 11 position as hitherto supposed. The position of the carboxyl group in abietic acid was determined by the researches of Ruzicka and Haworth and the fact that the acid and its ester combine with maleic anhydride[14] proved the presence of a system of conjugated double bonds and thus the skeleton of abietic acid was conjectured. The suggested formula of abietic acid, however, is only derivable from irregular isoprene chains. It has now been shown by Wienhaus[22] *et al* that abietic acid and maleic anhydride do not react below 130° to an appreciable extent. The primary acids of pinus sylvestris react at ordinary temperature both with maleic anhydride and benzoquinone. Therefore the conjugated double bonded system in abietic acid is unproved and the spectroscopic and refractometric measurements also do not indicate it.

The stereochemical problems arising out of the *cis*- and *trans*-locking of the polycyclic hydroaromatic compounds present an almost insurmountable obstacle in the determination of structure of these bodies. Refractometric measurements[15] and a comparison of m.ps. of different derivatives with those in the decalin series indicate that cholestane has a trans-trans-cis or trans-trans-trans configuration. It has been pointed out



III



IV

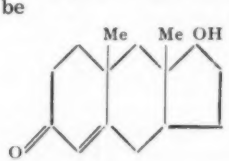
that the trans fusion of the rings II and III may well account for the non-formation of ketones from 1 : 6 dicarboxylic acids obtained by the opening of ring II or III. Much of the work on the stereochemistry of the sterols is due to Ruzicka[28] who has dealt with the assignment of the configurations. Practically all the known steroids belong to one of two ring systems: (*a*) the cholestane type or (*b*) coprostane type. These differ in the orientation of the hydrogen on C_5 relative to 10-methyl group which is *trans* in type (*a*) and *cis* in type (*b*). Ruzicka's view is that cholestanol has the locking trans, trans-antitrans-antitrans configuration. The hydrolysis of acetates and benzoates of epimeric pairs (*a*) cholestanol and epicholestanol, (*b*) coprostanol and epicoprostanol, (*c*) cholesterol and epicholesterol showed that all compounds denoted as *trans* were more readily hydrolysed than the *cis*-epimerides.

The original Rosenheim-King formula was based on the formation of chrysene by the dehydrogenation of cholic acid. Ruzicka reinvestigated the problem but could not find any chrysin. Ergosterol gave a hydrocarbon $C_{26}H_{26}$, the next higher homologue of the hydrocarbon $C_{25}H_{24}$ produced from cholesterol. The synthesis of Diel's hydrocarbon by Bergmann and Hillemann showed that during selenium dehydrogenation the migration of a methyl group occurs and the value

of this method becomes thus questioned. However, subsequent researches from many countries have now proved the conditions under which an angular methyl group may migrate and therefore the method is still a valuable one for determining structure.

Androsterone.—The male sexual hormone $C_{19}H_{30}O_2$ isolated in minute quantities was proved to be a hydroxy ketone. Its sterol-like structure was merely surmised. Ruzicka[17] found that β-cholestanyl chloride and cholestanyl acetate could be oxidised by chromic acid to ketones in which the side chain is completely removed. In a later paper the oxidation[18] of three remaining isomerides of cholestanyl acetate was described. The substance derived from epidihydrocholesterol had an activity equal to that of the natural hormone and was identical with it. Ruzicka has suggested that androsterone arises in nature by a process similar to that by which it is prepared *in vitro*—epimerisation of the hydroxy group of dihydrocholesterol followed by the oxidation of the side chain.

The question of the activity of these hormones has been studied and it has been found that androstane diol[19] is four or five times more active in promoting growth of comb but only slightly more active in promoting vesicular growth than androsterone. The most active of all is testosterones, a substance isolated from tests by Laquer,[20] which is five times as active as androsterone in promoting growth of comb and twenty times more active in promoting vesicular growth. The structure of testesterone[21] was shown to be



David[23] confirmed this view by oxidising it to androstene 3 : 17 dione.

It seems that testesterone is the true hormone and that androsterone and related substances are products of its metabolism.

It was shown by Laquer that testesterone displays its maximum biological activity only in presence of an 'X-substance' present in testicular extracts. It was shown that by esterification of testesterone, its activity is much enhanced. The most active ester was found to be the propionate[24] which is now used clinically under the name 'perandren'.

The Triterpenes.—The determination of m.w. of triterpenes presents many difficulties. Recent investigations have shown that many of these compounds may have as many as 30 C atoms.[25] The functional groups are difficult to detect. The CO group in $\alpha\beta$-unsaturated ketones could only be detected spectroscopically and the acid groups would not esterify under ordinary conditions. The action of ozone is unreliable and perbenzoic acid gives unsatisfactory results.

The results of dehydrogenation of the triterpenes are now available and much of the information has been supplied by Ruzicka and his collaborators. As a result of these investigations the structure of oleanolic acid and hederagenin are now fairly clear.

The isoprene rule is now so firmly established that more than usual interest attaches to the problem of the structure of artemesia ketone which violates the isoprene rule. The structural position has been consolidated by the synthesis[26] of its tetrahydro derivative from *aa*-dimethyl butyryl chloride and *iso*-butyl zinc iodide $CHMe_2.CH_2ZnI + ClCO.CMe_2Et = CHMe_2.CH_2.CO.CMe_2Et$.

Large carbon rings.—The preparation of the ring ketones by the distillation of the calcium salts of normal $a\omega$ fatty dicarboxylic acids has been restricted to the preparation of C_5, C_6 and C_7 cyclic ketones which can be obtained in about 30% yield. The cyclo octanone prepared by this method was found to be a mixture. Ruzicka[29] showed that 5% pure cyclo-octanone could be prepared from calcium azelate and 10% from cerium azelate. By the use of thorium salts the yield could be increased to 25%. The identification of by-products (cyclohexanone and nonanone-2) proved that the azelaic acid underwent fission to a pimelate and an acetate. Cyclononanone was also prepared in poor yield, due no doubt to the fission of the dicarboxylic acid. The higher ketones C_{10} to C_{18} were obtained by the vacuum distillation of the corresponding thorium salts. The yield of the ketones passed through a minimum (0·1–0·2%) at C_{10} and thereafter rose. The odour of the ketones resembled civet from C_{16} to C_{18}. According to the classical theory of Baeyer, the strain in a cycloheptadecane is $-24°41'$ whilst a cyclopropane has $+24°44'$. But the cyclic ketones from C_7 to C_{18} underwent no change when heated with concentrated hydrochloric acid

at 180–200°. Cycloheptadecanone was passed over thoria at 400–420° and was recovered unchanged. Therefore, it became clear that the larger rings relieved their strain by throwing up some of the carbon atoms in space. This was evident from the consideration of volume contribution of CH_2 in an alkane and a cycloalkane. The volume contribution of CH_2 in an alkane is 16·1, whilst the following values were obtained for cycloparaffins:

No. of CH_2 groups	4	5	6	7	15	17
V/*n*	20·4	18·8	18·0	17·3	16·1	16·1

The values for the smaller rings represent the volume occupied by CH_2 groups *plus* a share of the internal space. From C_{15} onwards the carbon atoms completely fill up the internal space and hence the value becomes equal to the CH_2 of an alkane. The value for heat of combustion of the methylene group has been found[30] in large rings to be 156 to 157 Kg-Cals. This corresponds to 157 Kg-Cals. for the methylene group in a paraffin and thus there can be no doubt as to their multiplanar configuration.

The structure of muscone (the ketone of musk) was found to be a methyl cyclopentadecanone and civetone, the ketone from civet cat was proved to be a heptadecanone. The synthesis[31] of *dl* muscone was effected in 1934 and in 1935 members of the C_{33} group were described as also the preparation of 7 to 18 membered saturated and unsaturated cyclic imines.[32] Civetone was converted into *iso*-oxime by ammonia and hydrochloric acid in benzene, the *iso*-oxime was converted into thio-oxime and then reduced with sodium and acetic acid in ethanol and heptadecamethyleneimine isolated. The polymethylenes (16 membered) attached to a benzene ring in *meta* and *para* position[33] were also prepared.

The modified quinatoxins.—Ruzicka[34] prepared a series of quinatoxine like compounds, *e.g.*, 4-quinolyl-(ε-aminopentyl) ketone, 4-(6-methoxyquinolyl ε-aminopentyl ketone, 4-pyridyl δ-methylaminobutyl ketone, 4-(6-methoxyquinolyl)-(δ-aminobutyl)ketone, etc. These compounds were tested by Giemsa but found to have no curative value. These experiments are significant in view of the later discovery of plasmoquin.

The above summary gives a very imperfect idea as to the versatility of Ruzicka's mind. The recognition of his work by the award of a Nobel Prize is an encouragement to all workers in organic chemistry as unlike other branches of science, work in organic chemistry involves considerable spade work and the results have little appeal to the lay public.

J. N. RAY.

University Chemical Laboratory,
Lahore.

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1 *Annalen*, 1911, **380**, 278–303.
2 *Ber.*, 1917, **50**, 1362–74.
3 *Helv. Chim. Acta.*, 1918, **1**, 110.
4 *Ibid.*, 1919, **2**, 182–88.
5 *Ibid.*, 1921, **4**, 666.
6 *Ibid.*, 1922, **5**, 345, 562, 710.
7 *Ibid.*, 1923, **6**, 483–502.
8 *Ibid.*, 1925, **8**, 259.
9 *Ibid.*, 1924, **7**, 379.
10 *Ibid.*, 1930, **13**, 1117.
11 *Ibid.*, 1930, **13**, 1402.
12 *Ibid.*, 1932, **15**, 3.
13 *Ibid.*, 1925, **8**, 637.
14 *Ibid.*, 1932, **15**, 1289.
15 *Ibid.*, 1933, **16**, 327.
16 *Ibid.*, 1933, **16**, 216, 812.
17 *Ibid.*, 1934, **17**, 1387.
18 *Ibid.*, 1934, **17**, 3519.
19 *Ibid.*, 1935, **18**, 210.
20 *Z. Physiol. Chem.*, 1935, **233**, 281.
21 *Helv. Chim. Acta*, 1935, **18**, 1264.
22 *Ber.*, 1936, **69**, 2198.
23 *Acta. Brev. Neerl*, 1935, **5**, 85.
24 *Helv. Chim. Acta.*, 1936, **19**, 1141.
25 *Ibid.*, 1932, **15**, 472; 1936, **19**, 1136, 1402; 1937, **20**, 312.
26 *Ibid.*, 1936, **19**, 646.
27 *J. Soc. Chem. Ind.*, 1935, **54**, 509.
28 *Helv. Chim. Acta.*, 1936, **19**, 842; 1937, **20**, 1557.
29 *Ibid.*, 1926, **9**, 389.
30 *Ibid.*, 1933, **16**, 162.
31 *Ibid.*, 1934, **17**, 1308.
32 *Ibid.*, 1935, **18**, 659.
33 *Ibid.*, 1932, **15**, 1220.
34 *Ibid.*, 1924, **7**, 995.

THE SEVENTH INTERNATIONAL CONGRESS OF GENETICS

THE SEVENTH INTERNATIONAL CONGRESS OF GENETICS held at Edinburgh during August-September last year was one of the most unique in the history of scientific conferences. Meeting under the threat of a great political upheaval, it achieved probably more than any previous session. And that it was held at all was due to the untiring efforts of Prof. F. A. E. Crew and his colleagues on the Committee. Originally Prof. N. I. Vavilov was to have presided over the deliberations but only about a fortnight before the session, information having been received of his inability to attend, Prof. Crew was elected to the chair. The Russian contingent of delegates failed to arrive at the last moment and the German geneticists had to withdraw, and in the face of these set-backs the determination to carry on and to continue the deliberations is itself an example of the undying spirit of Science.

Important contributions were made to our knowledge of the gene and the chromosome theory. The variations in the behaviour of the chromosomes at meiosis were shown by Darlington to be due to the changes occurring during the process of pairing of the chromosomes, while the structural changes in the chromosomes were shown by Muller to be due to a breakage of the chromonema at two or more points followed by a two-by-two junction between the adhesive broken ends, giving a new linear order. Another important new point brought to light was that the variations in the staining of the chromosomes were correlated with variations in gene activity. The cause for gene mutation was determined by Timoféeff-Ressovsky that it was due to atomic activations, brought about by kinetic energy of thermal origin and to individual ionizations resulting from radiation. The effect of ultra-violet light on chromosomes was discussed by Stadler and others and the experiments of Muller and Mackenzie showed that it was probable that ultra-violet light did not act by breaking the chromosomes, thereby concluding that gene mutations did not consist merely in linear rearrangements. Stadler also showed that gene mutations often affect only one of the chromatids.

Probably never before was the close association between gene change and chromosome change so clearly demonstrated and this was done in regard to *Drosophila* by the American geneticists. This has brought genetics and cytology into such an intimate unity that the two are being used as a "joint tool of evolutionary research".

The effect of genes on physiological and embryological processes was dealt with in a number of papers. The development of abnormalities was discussed by Landauer who showed that teratological phenomena could be explained by a general deleterious effect on growth rate at certain critical periods in development. Another important contribution to the section of physiological genetics was that by Sewall-Wright on guinea-pig coat colours where he suggested a scheme for the relations of the known genes in this animal.

The Congress made definite advances in our knowledge of the breeding and improvement of live-stock. Discussions on the adaptability of cattle to varied environments revealed certain significant differences, as observed by Manresa and others, in the hæmoglobin content of the blood in relation to atmospheric conditions.

The importance of statistical methods of inquiry in regard both to animal and plant genetical experiments was discussed at one of the joint meetings and it was seen that while at present the full benefits of statistics were not available to the plant and animal breeder on account of the inherent difficulties involved in the collection and evaluation of records, detailed analyses of statistical data were necessary for the correct interpretation of genetical phenomena. In fact, one of the general resolutions of the Congress lays stress on statistical studies and recommends the study of statistics in secondary institutions. In the field of plant breeding, the experiments on the breeding of maize has advanced farther than in any other cereal but it is probably in the field of horticultural breeding that the collaboration of genetics and cytology is seen at its best and most successful. The Edinburgh meeting has definitely paved the way for a successful tackling of the problem of devising the most effective and fruitful methods of collaboration between genetics, cytology and statistics.

A number of aspects of human inheritance were discussed, of which feeblemindedness

was dealt with by Fraser Roberts who believes that it is a case of multifactor inheritance, there being a number of genes, any pair of which are able to determine idiocy or imbecility. The genetics of many other diseases like epilepsy and Pick's disease were also discussed. Interesting cases of linkage were brought to light, like that between tooth deficiency and hair colour, reported by Barbara Burks. Reports on a number of disorders and abnormalities were also made.

The phenomenon of growth, normal or abnormal, as examined by the genetical viewpoint offers interesting study and as observed by E. B. Ford, growth may be determined by a single pair of factors or by numerous ones which might affect growth by co-operation. It is also necessary to make a distinction between cell-growth and division on the one hand and body growth on the other and it is probable that the genetic influence may affect the former directly and the latter only indirectly. The effect of the endocrine organs on general body growth is well known and any genetical influences on the former will produce consequent results on the latter. A study of cancers and tumours has shown that the growth of these comes under the influence, not only of genetical but also of environmental factors.

Wider aspects of genetical research and their bearing on general problems of evolutioonary biology were discussed in a special session. The observation that evolutionary change taking place not only under laboratory conditions but also in Nature must be investigated, was made by Dobzhansky. The bearing of taxonomy on evolutionary phenomena was stressed by J. S. Huxley who observed that the study of taxonomy was the study of evolution in action in the field.

B. R. S.

THE ANATOLIAN EARTHQUAKE OF DECEMBER 27, 1939

BY

A. R. PILLAI AND M. R. RANGASWAMI

(Colaba Observatory, Bombay)

A DISASTROUS earthquake occurred in Anatolia at $5^h\ 27^m$ I.S.T. ($1^u\ 57^m$ Turkish Standard Time) on December 27, 1939. The shock was recorded as one of great intensity by the seismographs at the Indian Observatories and the tentative epicentre as determined on the basis of the data reported from Agra, Calcutta, Kodaikanal and Colaba is found to lie in the region of Lat. 40° North and Long. 36° East, that is about 40 miles to the southwest of Tokat in Asia Minor. From a long time Asia Minor has been known to lie in one of the two major seismic belts in the world and has been visited by destructive earthquakes. According to Davison,[1] there were 48 destructive earthquakes in this region during the nineteenth century alone. From 1900 to 1928 nine large shocks were recorded in the same area. After a lull of about ten years this region appears to have once again become active. On April 19, 1938, a disastrous earthquake occurred in this region and the epicentre as located on the basis of the Indian seismograms was at Lat. 40° N. and Long. 33° E. This shock resulted in the complete destruction of ten villages; the number of victims exceeded 800. A slightly less destructive earthquake was also reported to have occurred on September 22, 1939, in the neighbourhood of Smyrna and the epicentre was found to be near Lat. 37° N. and Long. 26° E., about 100 miles away from Smyrna in the Aegian Sea. In this case, according to Reuter's news report, several villages around Smyrna were destroyed and more than 200 people killed. Another destructive shock, but less severe in its havoc, occurred in Anatolia, on November 23, 1939, but the Colaba records did not show clear phases. Sixteen villages were destroyed and 43 people were killed. These earthquakes were followed by the present catastrophic shock of December 27, 1939. According to the press reports so far received, fifteen provincial towns and ninety villages and hamlets were reduced to ruins and more than 39,000 people killed as a result of this earthquake. The shock was particularly severe in the agricultural regions between Tokat and Sivas, and in the districts of

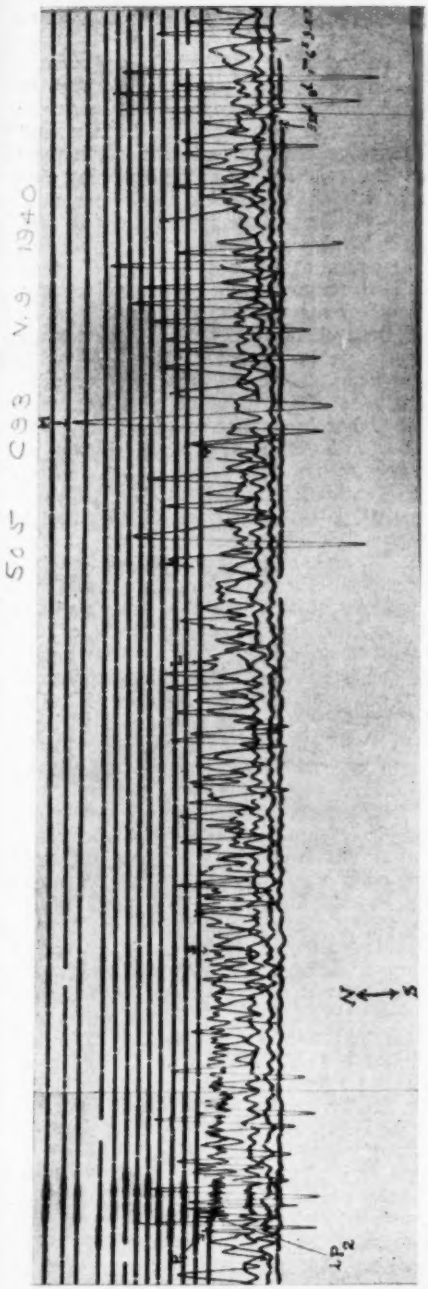

Fig. 1
Anatolian Earthquake, December 27, 1939. Colaba (Bombay), Milne-Shaw Seismogram (N-S) Component

Erzinjan and Kemakh every town and village is a heap of wreckage. The estimated total area that was severely affected by the shock is about 60,000 square miles.

The seismogram of this earthquake as recorded at Colaba by the Milne-Shaw seismograph (N-S component) is reproduced in Fig. 1. The first movements in the seismograms of the Colaba N-S and E-W components are very small as compared with the intensity of the shock. It is considered probable that the larger shock was preceded by a small foreshock with an interval of about 25 seconds between them. It is rather difficult to make any definite statement regarding the depth of focus of the shock until seismograms from other stations also are examined. It can, however, be said that the Colaba seismograms appear to show that the earthquake was not of abnormal depth. Considering the extent of the area affected it is probable that there were more than one shock with different epicentres along the same belt.

The magnitude and energy of the shock have been calculated from Colaba records only, following the method of Gutenberg and Richter.[2] The value of the magnitude comes to 7·1 and that of the energy of the earthquake, 10^{21} ergs. The other catastrophic earthquake in the year 1939 was the Chilean shock of January 25, 1939. The magnitude and energy of this earthquake were found to be 7·5 and 10^{22} ergs respectively.[3] Thus the energy released by the present Anatolian earthquake is about one-tenth that of the Chilean shock though in the matter of destruction of human life and property the former exceeds the latter. The magnitude and energy of this Anatolian earthquake is almost equal to those of the Baluchistan Quetta earthquake of May 31, 1935. But in loss of life, the Anatolian earthquake with a toll of above 39,000 lives almost ranks with the Messina-Reggio earthquake of December 28, 1908, which so far holds the record with the greatest death roll of over 47,000 as a result of the earthquake alone.

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[1] *Earthquakes and Other Earth Movements*, by John Milne. Revised by A. W. Lee, 1939, p. 143.

[2] *Gerlands Beitrage zur Geophksik*, 1936, **47**, 122–24.

[3] Savur, S. R., and Mukherji, S. M., *Curr. Sci.*, 1939, **8**, 156.

396199

CRYSTAL PHYSICS AND CHEMISTRY

UNDER the auspices of the fifth annual meeting of the Indian Academy of Sciences a symposium on "Crystal Physics and Chemistry" was held at Bangalore on the 31st December 1939. PROF. SIR C. V. RAMAN, the President of the Academy, was in the chair.

PROF. K. S. KRISHNAN spoke on the Stark splitting of the energy levels of paramagnetic ions in crystals under the influence of the strong electric fields due to the distribution of negatively charged atoms surrounding the paramagnetic ion. Three properties of the crystals which are largely affected by this are the optical properties, specific heat and the magnetic properties. In particular, the effect of this splitting on the magnetic behaviour of the ions throws considerable light on the origin of the magnetic anisotropy in a paramagnetic crystal. In crystals the orbital moments of the ions are partially quenched by the asymmetric crystalline electric fields. The spin moments, on the other hand, are not affected directly by the crystalline fields though indirectly they would be through their coupling with the orbital moments. The ground states of ions such as Mn^{++} Fe^{+++} and Gd^{+++} being S-states, there are no orbital moments to be quenched, and the magnetic moment is wholly due to the spin. The anisotropies in such cases are very feeble and arise from the Stark splitting of the S levels. From the magnetic data at room temperature, it is possible to get an idea of the Stark separation, the restriction of freedom of the ions, as well as the characteristic temperatures in the case of manganous and ferric salts. In the case of trivalent chromium, Cr^{+++}, also the magnetic moment is wholly due to the spin and it has, therefore, only a small anisotropy which follows the inverse square law with temperature. From the measurements on the magnetic anisotropy of nickel salts at different temperatures the strength of the coupling between the orbital and spin angular momenta of Ni^{++} has been calculated and is found to agree with the spectroscopic value. The striking contrast in the magnetic behaviour of the six co-ordinated and four co-ordinated cobalt compounds can be explained as due to the mutual inversion of the Stark levels of the Co^{++} ions in crystals. The effect of the spacing of the levels on the colour of the substances is also striking as the six co-ordinated cobalt compounds are pinkish whereas the four co-ordinated ones are blue. The phenomenon of magnetic double-refraction observed by Raman and Chinchalkar in solutions of rare earth salts can also be readily explained as being due to the asymmetric quenching of the orbital moments of the paramagnetic ion in the electric fields due to the surrounding anions, since the paramagnetic complex will then possess both magnetic and optical anisotropy. In the case of the solution of salts of Gd^{+++} the magnetic double-refraction is extremely feeble as is to be expected since Gd^{+++} is in the S-state and hence there is practically no magnetic anisotropy of the complex. Further, it has been observed that the Stark components in the absorption bands of crystals of certain rare earth salts have different polarisation characteristics, thus clearly demonstrating the existence of asymmetric crystalline fields in these crystals.

PROF. S. BHAGAVANTAM gave a brief review of the present theoretical conceptions about the dynamics of the crystal lattices and the recent progress made in the study of the scattering of light in crystals. From Born's theory of crystal lattices, the modes of motion can be classified into two fundamental groups: (1) the acoustical series—same as the Debye heat waves—due to the simultaneous translatory motion of all the atoms defined by the elastic properties of the crystal, and (2) the optical series occuring in Raman effect and infra-red absorption which consist in the oscillation of the ultimate constituents that go to make up the crystal lattice, against each other. In class (2) the periodicity of oscillations of the set of atoms in space can be so varied as to get different modes of oscillation. However, only those modes are important in light scattering where all the atoms move in phase to produce the necessary polarisability changes. The change of symmetry of the crystal changes the number of distinct modes, the higher the symmetry the smaller being the number of these modes. One of the important symmetry elements is the centre of symmetry. The significance of the location of the centre of symmetry is clear from the different behaviour of sodium chloride as compared to that of diamond in light scattering. The geometric arrangement of the scattering units in crystal lattices

and their simplicity render the results obtained by light-scattering both accurate and easy of interpretation. One can get a variety of information from studies of the Raman effect in single crystals under different experimental conditions. The lecturer showed how the recent directional studies on calcite and sodium nitrate enabled one to draw important conclusions regarding the dynamics of their lattices.

DR. C. S. PICHAMUTHU detailed the mineralogical aspect of various properties of crystalline rocks. He referred briefly to the use of the more common optical instruments such as the polarisation microscope and the Federow stage to determine the optical constants of minerals. The optical anomalies such as the occasional biaxiality and anomalous interference colours shown by hexagonal crystals like quartz and garnet have puzzled the mineralogists till now. In the case of lavas and spherulites which are formed in a fine state of crystallisation, the mineralogist has recourse only to X-ray studies to find out their structure. In the case of ore minerals, studies are made by reflected light and by etching methods because of the opacity of the crystals. However, the study of the distribution of components in the ore samples is rather difficult. The lecturer then dealt in detail with the formation and characteristics such as the orientation effects in stress minerals.

PROF. SIR C. V. RAMAN gave suggestions regarding the methods to be adopted in resolving some of the optical anomalies observed in minerals and stressed the possible influence of irregularities and crystal imperfections such as the mosaic structure on the optical behaviour of crystals particularly in light scattering.

MR. T. M. K. NEDUNGADI drew attention to the usefulness of the study of light scattering in crystals in the explanation of their various physical properties. He showed how his studies of the Raman spectrum of quartz at high temperatures have given an insight into the probable mechanism of the α–β transformation in quartz.

Some interesting new results obtained from studies on the luminiscence, light-scattering and light absorption in diamonds were presented by MR. P. G. N. NAYAR. Diamonds in general have a number of fluorescent bands. But among the different crystals there is wide variation in their intensities. Certain correlations between the frequency differences of the luminescent bands and infra-red and ultra-violet absorption were pointed out and discussed.

T. M. K. NEDUNGADI.

A NATIONAL RESEARCH COUNCIL FOR INDIA

IN the December Number of *Current Science*, in an Editorial we pleaded strongly for the immediate inauguration of a National Research Council, on lines similar, in essentials, to the Department of Scientific and Industrial Research in Great Britain, for organising industrial research in this country. It is gratifying to learn that this suggestion has received strong support from the scientists of this country who had assembled at Madras under the auspices of the Indian Science Congress. At a meeting held on the 5th of January, under the Presidentship of Sir T. Vijayaraghavacharya, various speakers, including Profs. J. N. Ray, S. P. Agharkar and J. N. Mukherjee, spoke on the role of science in national planning and drew attention to the existence of lacunæ in our scientific organisation. The inauguration of a National Research Council at this stage of scientific development in India, was considered essential for an ordered utilisation of the industrial resources of the country. In bringing the proceedings to a close, Sir T. Vijayaraghavacharya mentioned that as long ago as 1931, he had suggested the formation of a national council of research for organising not only agricultural but also industrial research. He felt that the formation of such a body was long overdue.

A Committee consisting of Sir T. Vijayaraghavacharya (*President*), Prof. Birbal Sahni, Dr. J. C. Ghosh, Bt.-Col. R. N. Chopra, Prof. M. N. Saha and Prof. P. Parija (*Secretary*), was appointed to prepare a memorandum relating to the establishment of a National Research Council for India for being submitted to the Government of India.

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Interaction of Atomic Energy Levels Part II

In continuation of the work previously reported in *Current Science*,[1] the spectra of mercury and of cadmium and of their mixture have been studied by the same method as before. Some lines of the two elements have disappeared in the spectrum of the mixture, while some lines not to be seen in the spectra of the individual metals make their appearance. Other lines suffer a greater or less modification of intensity, but many lines remain unaffected. The following list contains all the lines thus modified. Brackets indicate that the change of intensity is not large.

Cadmium Lines

Weakened

[6438·47 ($5^1P_1 - 5^1D_2$)]
6329·91 ($5^1P_1 - 5^3D_1$) (absent)
6325·19 ($5^1P_1 - 5^3D_2$)
6111·52 ($6^3S_1 - 8^3P_1$) (absent)
6099·18 ($6^3S_1 - 8^3P_2$) (absent)
2881·23 ($5^3P_1 - 6^3D_1$)
2880·77 ($5^3P_1 - 6^3D_2$)
2868·26 ($5^3P_2 - 8^3S_1$)
2836·90 ($5^3P_0 - 6^3D_1$)
2775·00 ($5^3P_1 - 8^3S_1$)
2733·88 ($5^3P_0 - 8^3S_1$)

Strengthened

2677·64 ($5^3P_1 - 7^3D_2$) (new)
2660·40 ($5^3P_2 - 8^3D_3$) (new)
2602·18 ($5^3P_2 - 9^3D_3$) (new)
2288·02 ($5^1S_0 - 5^1P_1$)
2265·05 (Cd II $5s^2S_{1/2} - 5p^2P_{3/2}$) (new)

Mercury Lines

Weakened

5790·66 ($6^1P_1 - 6^1D_2$)
5789·69 ($6^1P_1 - 6^3D_1$)
5769·60 ($6^1P_1 - 6^3D_2$)
[5460·74 ($6^3P_2 - 7^3S_1$)]
3983·92 (Hg II $5d^96s^22D_{5/2} - 5d^{10}6p^2P_{3/2}$) (absent)
{[3663·28 ($6^3P_2 - 6^1D_2$)]
[3662·88 ($6^3P_2 - 6^3D_1$)]}
[3654·83 ($6^3P_2 - 6^3D_2$)]
[3650·15 ($6^3P_2 - 6^3D_3$)]
2804·46 ($6^3P_2 - 8^3D_2$)
2803·48 ($6^3P_2 - 8^3D_3$)
2698·85 ($6^3P_2 - 9^3D_3$) (absent)
2639·93 ($6^3P_2 - 10^3D_3$) (absent)
2603·15 ($6^3P_2 - 11^3D_3$) (absent)
2578·44 ($6^3P_2 - 12^3D_3$) (absent)

Strengthened

[4077·83 ($6^3P_1 - 7^1S_0$)]
2655·13 ($6^3P_1 - 7^1D_2$)
2653·68 ($6^3P_1 - 7^3D_1$)
2652·04 ($6^3P_1 - 7^3D_2$)
[2536·52 ($6^1S_4 - 6^3P_1$)]
2534·80 ($6^3P_0 - 7^3D_1$)
2464·02 ($6^3P_2 - 9^3S_1$) (new)

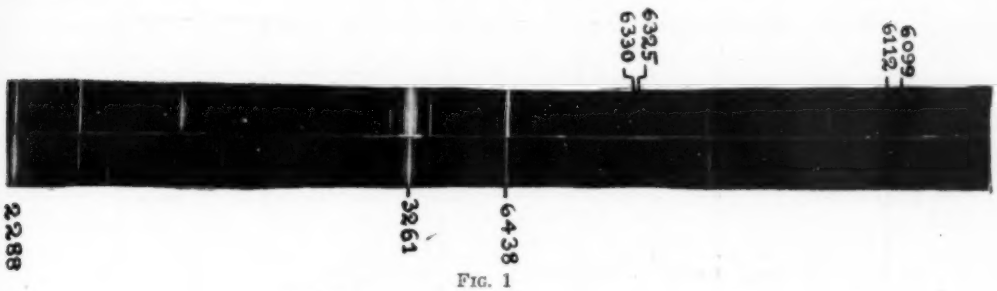


FIG. 1

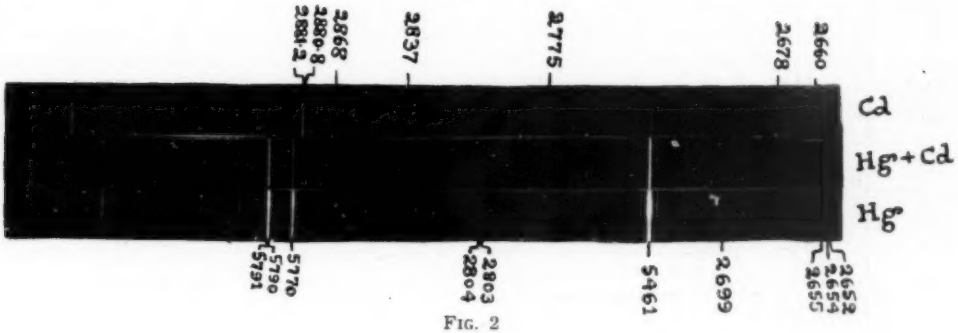


FIG. 2

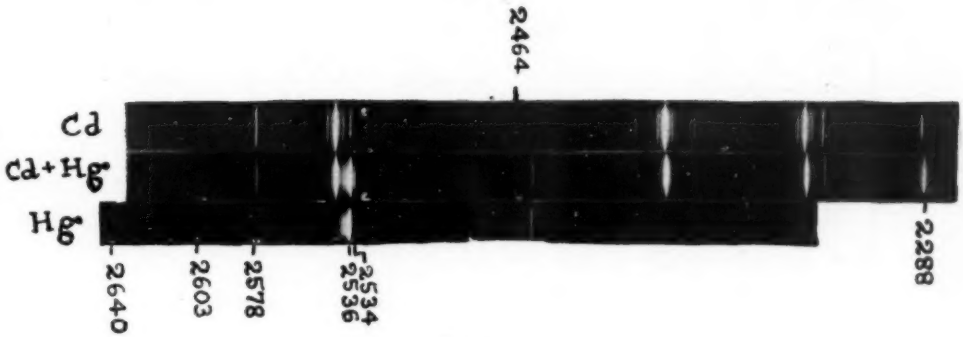


FIG. 3

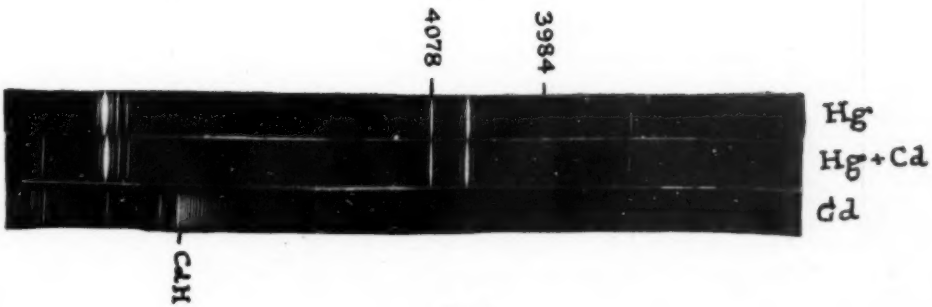


FIG. 4

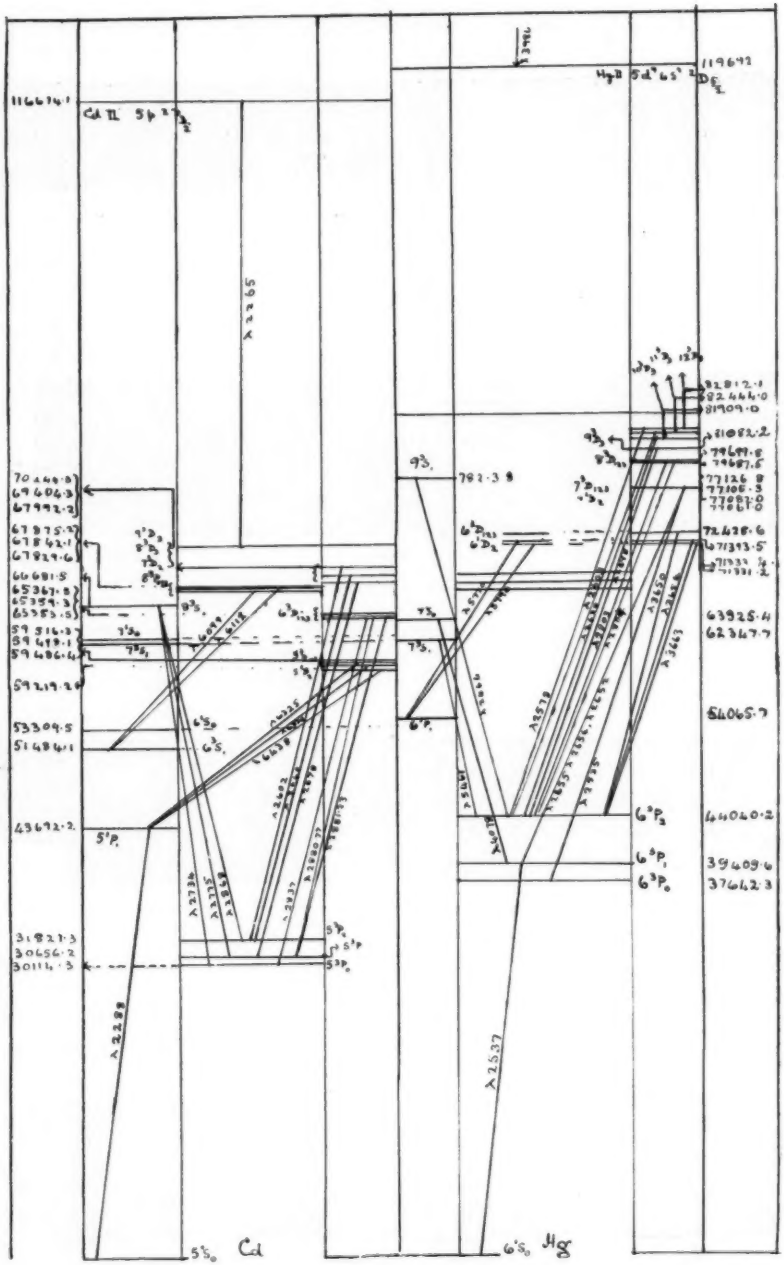


FIG. 5

The resonance line 2537 of mercury shows complete self-reversal in mercury but no trace of reversal in the mixture. The 2540 band accompanying 2537 is present in mercury and in the mixture with cadmium, whereas it disappeared in the mixture with zinc. Similarly the ZnH bands appearing in zinc continued strong in the mixture with mercury, but the CdH bands, though present in cadmium, disappeared in the mixture of mercury and cadmium. The resonance line of zinc 3076 was weaker than 3345 in pure zinc but became stronger than the latter in the presence of mercury; on the other hand, the cadmium resonance line 3261 was stronger than 3610 in cadmium and continued to be so in the mixture.

Of the various instances of alteration of line intensity enumerated above, the strengthening of 2288 is the easiest to explain. The excitation energy of 5^1P_1 of Cd is 43692·2 cm.$^{-1}$ while the metastable 6^3P_2 state of mercury has an energy very close to this, *viz.*, 44040·2 cm.$^{-1}$. Hence the probability of the latter exciting the former is high and so 2288 is strengthened. The slight weakening of 5461 shows that some atoms are removed from the 7^3S_1 state without dropping to the 6^3P_2-level. Taking this with the fact that the Cd lines 6438 ($\nu = 15527$ cm.$^{-1}$), 6330 ($\nu = 15794$ cm.$^{-1}$) and 6325 ($\nu = 15805$ cm.$^{-1}$) are weakened, we may assume that the energy of these lines raises the Hg atom from the 7^3S_1 state to the 7^3D_2, 7^3D_1 and 7^1D_2 states which differ from 7^3S_1 by 14757·6, 14734·3 and 14713·3 cm.$^{-1}$ respectively, say, by impacts of the second kind. This will then explain the brightening of 2655, 2654, 2652 and 2534. All these lines, except 2534, involve transitions to the 6^3P_1 state, so that the population of this state is increased. Hence we should expect 2537 to be brightened, as is actually the case. The brightening of 2655, 2654, 2652 and 2534 can also be due to mercury atoms in the 6^3P_2 state (energy 44040·2 cm.$^{-1}$) being raised to the 7^3D_2, 7^3D_1 and 7^1D_2 states by interaction with the metastable 5^3P_2 state of Cd (energy 31827·3 cm.$^{-1}$). The energies of 7^3D_2, 7^3D_1 and 7^1D_2 are 77061·0, 77082·0 and 77105·3 cm.$^{-1}$ respectively, and, the sum of the energies of 6^3P_2 of Hg and 5^3P_2 of Cd being 75867·5 cm.$^{-1}$, the deficiency is within what can be supplied by thermal energy. In a similar way, the energy of 6112 ($\nu = 16358$ cm.$^{-1}$) and 6099 ($\nu = 16391$) of Cd which are weakened must have been used to raise the Hg atom in the 7^3S_1 state to the 9^3S_1 state, the difference between which is 15866·1 cm.$^{-1}$. The new appearance of 2664 is thus explained. Of the cadmium lines which are weakened, the upper state of 2881·2 and 2836·9 is 6^3D_1 of energy 65353·5 cm.$^{-1}$, that of 2880·8 is 6^3D_2 (energy 65359·3 cm^{-1}) and that of 2868·3, 2775·0 and 2733·9 is 8^3S_1 (energy 66681·5 cm.$^{-1}$). These energies are sufficiently near the excitation energy of 7^1S_0 of Hg which is 63925·4, to make it probable that the strengthening of 4078 is due to this interaction. 5791, 5790, 5770, 3663, 3654 and 3650, all of which are weakened, have $6^3D_{1,2,3}$ and 6^1D_2 as their upper levels. Their excitation energies are 71333·4, 71393·5, 71428·6 and 71330·2 cm.$^{-1}$ and these are sufficiently near 7^3D_2, 8^3D_3 and 9^3D_3 of Cd (energies 67992·5, 69404·3 and 70250 cm.$^{-1}$) to explain the new appearance of 2678, 2660 and 2602 of Cd.

The weakening of 2804, 2803, 2699, 2640, 2603, and 2578 means the depopulation of 8^3D_2, 8^3D_3, 9^3D_3, 10^3D_3, 11^3D_3 and 12^3D_3 of Hg. The excitation energies are 79687·5, 79699·8, 81082·2, 81909·0, 82444·0 and 82812·1 cm.$^{-1}$. If these energies are added to the energy of the metastable $^3P_2$ state of Cd (= 31827·3 cm.$^{-1}$) we come sufficiently near to the excitation energy of 2265 of Cd II (116674·1 cm.$^{-1}$) for the difference to be capable of being supplied by thermal energy. The excitation energy of 3984 of Hg II (119692 cm.$^{-1}$) which has disappeared is also capable of explaining the new appearance of 2265. Since the excitation energies of 8^3D_2 ... 12^3D_3 of Hg are higher than the ionization energy of Cd, the explanation of the weakening of 2804, etc., must proceed in some such way as the above, but too much weight should not be attached to the disappearance of such weak lines as these.

Apart from explaining the observed changes of intensity, some clarification is required for the fact that no interaction has been found between other levels of Hg and Cd which are quite close to each other, *e.g.*, 6^1P_1 of Hg and 6^1S_0 of Cd, 7^3S_1 and 7^1S_0 of Hg and 7^3S_1 and 7^1S_0 of Cd, x^3P of Hg and 8^3P and 8^1P of Cd and so on. The theory of the interaction of atomic energy levels must be better developed for this to be possible. The present work is intended to provide an experimental basis for such a development. The transitions for the various wave-lengths are indicated in the level diagram appended (Fig. 5).

In conclusion it is a pleasure to record our thanks to Prof. A. Venkat Rao Telang, M.A., F.Inst.P., for his encouragement and many facilities afforded to us.

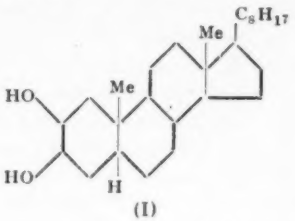
T. S. Subbaraya.
K. Seshadri.
N. A. Narayana Rao.

Physics Department,
Central College,
Bangalore,
January 12, 1940.

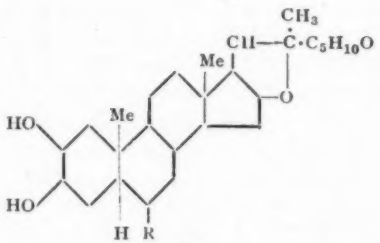
The Configurations of the C_2 and C_3 Hydroxyl Groups in Gitogenin and Digitogenin

It has been previously mentioned[1] in connection with the 2 : 3-dihydroxycholestanes (I) that the presence of the hydroxyl group at C_2 may not interfere with the digitonin precipitability and that of the four isomers of 2 : 3-dihydroxycholestanes, two, in which the C_3 hydroxyl groups are of the normal (β-) configuration, should precipitate with digitonin. This is now indirectly confirmed by the recent reports of Noller[2] and of Marker and Rohrman[3] that the 2 : 3-dihydroxysteroid sapogenins, gitogenin (II, R = H) and digitogenin (II, R = OH) precipitate with digitonin, contrary to what had been previously reported by Tschesche and Hagedorn.[4]

There are four theoretical possibilities of the relative configurations of the C_2 and C_3 hydroxyl groups in these sapogenins corresponding to the four stereoisomeric forms of 2 : 3-dihydroxycholestane[1] (of which in one the hydroxyl groups are in the *trans* and in the rest



(I)



(II)

in the *cis* positions). Basing on the report of Tschesche and Hagedorn[4] and also the behaviour of the three isomeric 2 : 3-dihydroxy*trans* decalins,[5] it was suggested[6] that the C_2 and C_3 hydroxyl groups in gitogenin and digitogenin are in transpositions to each other, the C_3 hydroxyl groups being of the *epi* (α-) configuration. Due to the observations of the American authors mentioned above, this suggestion is now revised.

Assuming the precipitation with digitonin to be having the same significance for the steroid sapogenins as for the sterols (Noller[2]), it is to be concluded that C_3 hydroxy group in gitogenin and digitonin is of the β-configuration—*i.e.*, it is *cis* to the C_{10} methyl group. By the other hydroxyl group at C_2, occupying the two possible positions *cis* or *trans* with reference to the C_{10} methyl group, two forms are possible in which the two hydroxyl groups (which are *cis* to each other in both forms) are unsymmetrical or symmetrical respectively about the plane of the carbon atoms 2, 3, 5 and 9. (These two forms correspond to those of B and A respectively of 2 : 3-dihydroxy*trans*decalin[5].) By

analogy with the behaviour of the 2:3-dihydroxy*trans*decalin of form B, we should expect the sapogenins to isomerise to the *trans* form on treatment with acid if these hydroxyl groups possessed the unsymmetrical configuration. Since this has not been observed, it may be concluded that in gitogenin and also in digitogenin the hydroxyl groups at C_3 and C_2 (which are in *cis* positions to each other) are *cis* and *trans* respectively with respect to the C_{10} methyl group.

K. GANAPATHI.

Haffkine Institute,
Parel,
Bombay,
December 28, 1939.

[1] Ganapathi, *Curr. Sci.*, 1939, **8**, 360.
[2] Noller, *J. Amer. Chem. Soc.*, 1939, **61**, 2717.
[3] Marker and Rohrman, *Ibid.*, 1939, **61**, 2724.
[4] *Ber.*, 1935, **68**, 2248.
[5] Ganapathi, *Ber.*, 1939, **72**, 1381.
[6] Ref. 1 footnote.

Elasticity of Organo-Gels in Relation to Hysteresis in Sorption

EXPERIMENTS on hysteresis in the sorption of vapours on organic natural colloids are few in the literature. Rao, B. S.,[6] and co-workers have expressed the view that rice is essentially a colloidal system having the characteristics of a gel. This view can be extended to all other grains and plant materials. The unique colloidal behaviour of the rice grain[7] of losing the hysteresis loop initially exhibited by it, when the cereal is subjected to successive sorptions and desorptions of water vapour has already been presented. This behaviour has revealed the rôle of elasticity of the swollen grain on hysteresis in sorption. This principle receives further striking confirmation by the results obtained by conducting a series of sorptions and desorptions of water vapour, on the calcium salt of gum arabic, presented in this paper.

Calcium arabate was prepared according to the method described by Briggs.[2] Gum arabic (5% solution of Merck's C.P. Quality) was precipitated by ethyl alcohol from an acid solution containing hydrochloric acid (0·1 N.). It was reprecipitated and partially dried in vacuum to remove the alcohol. In order to remove the electrolytes, an aqueous solution of this gum was subjected to hot dialysis, till the dialysate showed no change in conductivity. The method developed by Bernhart[1] and co-workers was adapted for hot dialysis. The dialysed solution was just neutralised with the requisite amount of calcium hydroxide. The solution was evaporated on a water-bath till thin flakes of calcium arabate were obtained. The flakes were powdered and activated at 60° C. in vacuum for half an hour. The activated calcium arabate was degassed in the sorption tube for five hours in vacuum and a series of sorptions and desorptions of water vapour at 30° C. were conducted with the aid of a McBain-Bakr quartz fibre spring balance.[5] The results are shown in Fig. 1.

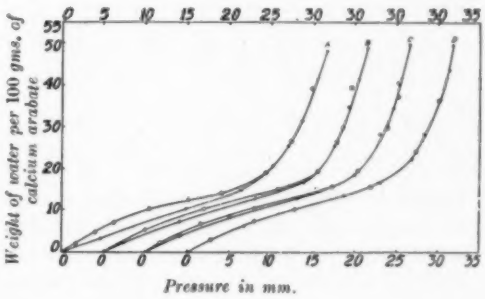


FIG. 1

A First sorption •—•—• and desorption o—o—o
B Second ,, ,, ,, ,,
C Third ,, ,, ,, ,,
D Fourth ,, ,, ,, ,,

A period of about a fortnight was necessary for completing each cycle of sorption and desorption. In the first cycle of sorption and desorption, calcium arbate exhibits a hysteresis loop which dwindles away in the subsequent cycles and completely disappears in the fourth cycle, the sorption and the desorption curves

being perfectly coincident. This interesting behaviour of calcium arabate, analogous to that of rice grain[7] leads to the following conclusion, in accordance with the cavity concept[3] which has already been established to be a general cause[8] of hysteresis in sorption. Calcium arabate on its initial activation, has capillaries some of which are open pores and some are cavities having narrow necks. In the beginning, these cavities have rigid walls. After they are filled up, they trap the water and retain it when desorption is effected. Thus the arabate retains, for the same vapour pressure, more of water during desorption than during sorption. With progressive sorption and desorption, however, the gum swells and the walls of the cavities become more elastic. With an increase in the elasticity of the cavity wall, the cavities are less effective in trapping water. Thus after a certain stage, i.e., in the fourth cycle of sorption and desorption, they have completely lost the power of trapping water, as indicated by the sorption and the desorption curves being coincident.

The hysteresis loop in the first sorption and desorption extends up to a relative humidity of 0·78. This corresponds to a maximum radius of 40·5 Å of the cavities in the sample of calcium arabate, as calculated from Lord Kelvin equation,[4,10] $ln\frac{p}{p_s} = \frac{-2\sigma v}{rRT}$, where p is the pressure at the concave surface, p_s the pressure of saturated vapour of liquid in bulk at that temperature, σ is the surface tension, v is the volume of one gram mol. of condensed liquid, r is the radius of the capillary, R the gas constant ($8{\cdot}315 \times 10^7$ ergs), T the absolute temperature, and *ln* represents the natural logarithm to the base *e*. The fact that the hysteresis loop stretches down to zero pressure, as in rice-water[7] system indicates that some of the cavities have necks of molecular dimensions. Compared with the activated rice grain, calcium arabate has much finer cavities. Some of the biggest cavities in rice, however, are of microscopic dimensions, as indicated by the peak of the hysteresis loop extending up to the saturation point.

Dhal grain (*Cajanus indicus*), a member of the dicotyledonous seeds, exhibits similar behaviour[9] of having a hysterisis loop in the first cycle of sorption and desorption which disappears in the subsequent cycles. A series of sorptions and desorptions of carbon tetrachloride vapour on the activated rice grain have shown the existence of a permanent hysteresis loop[9] which has been reproduced at the ninth sorption and desorption, whereas with water, the hysteresis loop exhibited in the first cycle of sorption and desorption has been found to disappear[7] in the third cycle.

All these observations afford a convincing proof of the view already expressed about the effect of elasticity[7] of the gel system on hysteresis in sorption. It is indeed probable, that all grains and plant materials, which become elastic by virtue of their property of swelling on the imbibition of water, exhibit no permanent hysteresis loop in the sorption of water and other solvating liquids. With nonsolvating liquids, however, there is no swelling and the porous gel retains its rigidity even after a series of sorptions and desorptions. The hysteresis loop should, therefore, remain permanent and perfectly reproducible as in rice-carbon tetrachloride system.[9] So, in all elastic gels, in the sorption of vapours of solvating liquids, as a rule, there should be no hysteresis loop. Even if there is a hysteresis loop, it should disappear after a certain number of sorptions and desorptions. Whether there is an initial hysteresis loop or not, depends upon the previous history of the gel, *e.g.*, drastic desiccation of the gel at high temperatures which may result in the production of cavities.

The investigations, *vide infra*, on a series of sorptions and desorptions of the vapours of different liquids, on a few typical organo-gels

have revealed the rôle of elasticity of organogels on hysteresis in sorption.

KITTUR SUBBA RAO.

Department of Chemistry,
Central College,
Bangalore,
December 27, 1939.

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[3] McBain, *J. Amer. Chem. Soc.*, 1935, **57**, 699.
[4] —, *The Sorption of Gases and Vapours by Solids*, George Routledge and Sons, Ltd., London, 1932, 433.
[5] —and Bakr, *J. Amer. Chem. Soc.*, 1926, **48**, 690.
[6] Rao, B. S., *Curr. Sci.*, 1938, **6**, 446.
[7] Rao, K. S., *Ibid.*, 1939, **8**, 256.
[8] —, *Ibid.*, 1939, **8**, 468; 1939, **8**, 546.
[9] —, Unpublished.
[10] Thomson, *Phil. Mag.*, 1871, (4), **42**, 448.

The 'Tyrosinase' from *Dolichos lablab*

IN view of the recent work[1-5] on phenolases which has revealed conflicting views regarding the existence of distinctly separate enzymes for the oxidation of the mono- and dihydroxy phenols, it was of interest to purify and elucidate the nature of the "tyrosinase" present in *Dolichos lablab*. The enzyme extract was obtained by an extraction of the dried and powdered seeds with saline (5 per cent. NaCl). On removal of the salt by dialysis, the globulins of the extract were thrown down, which were subsequently filtered off. The resulting clear light brown filtrate containing most of the enzyme was saturated with ammonium sulphate, when the enzyme was completely precipitated. A further purification of this precipitate was effected by fractional precipitations with alcohol and acetone and by adsorption on calcium phosphate gel.

The enzyme preparations oxidise catechol with great ease, while the oxidation of phenol, p-cresol, tyrosine, pyrogallol and "dopa" does not proceed with the same vigour. The course of oxidation of these substrates has been followed manometrically by measuring the oxygen uptake in a Warburg. Through a series of preliminary trials, the conditions for obtaining a measure of the activity of the enzyme preparations, were standardised. The oxygen uptake with phenol and p-cresol was found to be linear (after a short initial induction period) and proportional to the concentration of the enzyme. With catechol, as reported by Wagreich and Nelson,[5, 6] the oxygen uptake falls off rapidly, presumably due to inactivation of the enzyme. But the secondary oxidation of hydroquinone or ascorbic acid through the aid of the catechol as "carrier" proceeds at a rate which is a measure of the enzyme. The rate of oxygen uptake is proportional to the concentration of carrier within narrow limits (0·01 to 0·03 mgm. in 2 c.c.).

For a comparative study of the activity of the enzyme preparations towards mono- and dihydroxy phenols, the oxygen uptake with ascorbic acid/catechol and with phenol were measured. The oxygen uptake with hydroquinone/catechol and p-cresol also follow closely the above. The measurements were made at pH 6·2 on 1 mgm. quantities of substrate in a final volume of 2 c.c.

The following table indicates the effect of a preliminary purification on the activity of the enzyme towards the two different sets of substrates.

It will be observed that the activity towards phenol decreases as compared to catechol, with progressive purification. The induction period with phenol becomes prolonged while the oxidation of catechol begins instantaneously in every case. The addition of minute amounts of catechol (0·02 mgm.) to the phenol practically abolishes the induction period, increases the oxygen uptake, which, however, tends to fall off instead of remaining steady. In the fractional precipitations with alcohol and acetone, no other fractions of the enzyme with a comparatively greater activity towards phenol than catechol, could be obtained. The centrifugate after adsorption was also not more active towards phenol. These results suggest that the activity towards phenol (or p-cresol or tyrosine) is a secondary reaction depending on the

No.	Purification stage	Total solids mgm. per c.c.	Activity in mm. min./mgm. enzyme		Ratio (A)/(B)
			Ascorbic acid/catechol (A)	Phenol (B)	
1	Initial extract precipitated with Am_2SO_4 and precipitate suspended in water and dialysed	10	0·25	0·2	1·25
2	(1) Precipitated with alcohol in the cold 30-60 per cent. and precipitate taken up in water	6	6·0	5·0	1·20
3	(2) Precipitated with acetone in the cold 33–60 per cent. and precipitate taken up in water	2	3·7	2·1	1·8
4	(3) Adsorbed on $Ca_3(PO_4)_2$ gel at pH 5·0 and eluted with M/20 Na_2HPO_4	1·0	14·0	2·5	5·6
5	Further precipitation of (4) with acetone in the cold 33–60 per cent.	0·5	20·0	1·6	12·5

presence of a subsidiary factor, in addition to the main portion of the catechol (or diphenol) oxidase. This factor gets eliminated during the purification and is partly replaceable by catechol. Work on the further purification of the enzyme is being continued.

S. L. VENKATISWARAN.
M. SREENIVASAYA.

Department of Biochemistry,
Indian Institute of Science,
Bangalore,
December 20, 1939.

[1] Graubard and Nelson, *Jour. Biol., Chem.*, **111**, 757.
[2] Kubowitz, *Biochem. Zeits.*, **292**, 221.
[3] Califano and Stefani, *Nature*, **142**, 1036.
[4] Graubard, *Enzymologia*, **5**, 332.
[5] Wagreich and Nelson, *J. Amer. Chem. Soc.*, **60**, 1544.
[6] Adams and Nelson, *Ibid.*, **60**, 2474.

Vascular Anatomy of the Flower of *Macadamia ternifolia* F. Muell. (Proteaceæ)

SINCE the publication of an account of floral anatomy in *Macadamia ternifolia* F. Muell. sometime back[1] the writer had occasion to make a more detailed examination of the floral structure in the same plant. Some of the previous interpretations concerning the nature of the perianth traces and the morphology of the nectar-secreting disc at the base of the ovary are now found to be incorrect in certain respects. The writer is grateful to Prof. Arthur J. Eames, of Cornell University, U.S.A., who, being requested to give an opinion in the matter, very kindly pointed out the discrepancy in the earlier account.

It is stated in the paper cited above that the perianth in the modern Proteaceæ represents the whorl of calyx and that the marginal strands of the perianth segments which arise by forking of four large strands separating from the receptacular stele represent traces to a lost corolla. Such an interpretation was offered on the strength of the remarks by Joshi and Rao[2] in their work on the floral anatomy of some Nyctaginaceæ; these authors state with regard to the two sets of traces to the perianth that one method of interpreting is "that each set of traces belongs to a separate whorl of leaves and formerly in this family there were two whorls of perianth leaves, the traces of the lower set belonging to the sepals and those of the upper to the petals. At present these two sets of traces are running in the same whorl owing to the disappearance of one whorl." This interpretation is inconsistent with the detailed observations now made in *Macadamia ternifolia*. The perianth segments are strictly sepals in nature and their vascular connections are quite normal as in many other angiosperms

(Eames and MacDaniels, 1925),[3] each segment showing the usual midrib strand and two marginal strands (Fig. 5).

The origin of the midrib strand of the perianth segments is rather interesting. Corresponding to the four midrib strands of the four perianth segments there are formed as many pairs of strands separating from the receptacular stele. The members of each pair next move out upwards at the base of the flower (Figs. 3 and 4) and finally fuse with each other before actually entering a perianth segment as a large median strand (Fig. 5). In this connection Prof. A. J. Eames expresses in a personal communication: "The origin of the midrib trace of the sepal from two strands is remarkable." This point was, therefore, very critically examined and it is found that there is a distinct double origin of each midrib strand as shown clearly in Figs. 3–5 and in the Photomicrograph 1. From each midrib strand is then separated to the inside the single trace for the stamen (Figs. 1 and 5).

Regarding the nectar-secreting disc which develops as a ring-like structure at the base of the ovary, it is stated in the previous account that it is a new structure without any definite morphological status in the flower. This interpretation was based on a study of insufficient material and its exact nature could not be precisely determined. Further, it was influenced to some degree by the remarks of Brough[4] regarding the same structure in another member of the Proteaceæ, *Grevillea robusta* Cunn. Brough states that "The fact that the nectar scales are, in this family, often four in number, and alternating with the perianth segments, suggested" to him "that they might constitute a reduced and modified inner whorl of floral leaves, or in other words represent the vestiges of an ancestral normal corolla", but that "There is no indication, whatsoever, of any associated vascular tissue, and consequently, no ground for interpreting the scale as the morphological equivalent of a reduced perianth." On the other hand, a very careful examination of

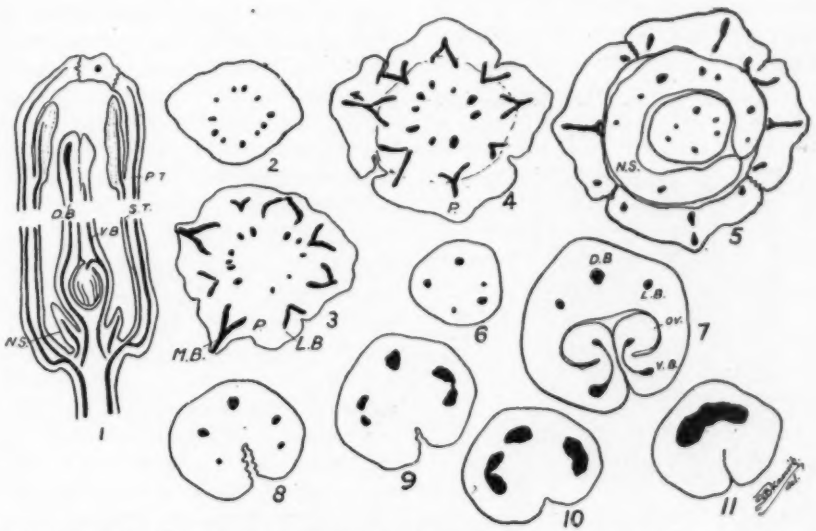

FIG. 1. Longitudinal section of flower showing the vascular connections for the various floral organs. FIG. 2. Transverse section of the base of flower. FIGS. 3–5. Series of transverse sections showing the departure of traces to the perianth segments. FIG. 6. Transverse section of the base of gynœcium. Fig. 7. Transverse section of the gynœcium at the region of the ovule showing ovule traces. FIGS. 8–11. Series of transverse sections of the style and stigma.

the disc as now made appears to throw definite light on its exact morphology in the flowers of *Macadamia*, which may presumably be true of the other Proteaceæ too. In the tissue of the disc there are found scattered here and there a few feebly developed vascular strands (Fig. 5), whose cell elements, however, do not seem to become fully tracheal in nature in so far as they lack the characteristic markings of the wall of a true tracheal tissue. They appear merely as strands (Fig. 1) composed of elongated cells with more and more diminished cell

PHOTOMICROGRAPH 1—showing the double origin of the midrib strand and the formation of marginal strands for the perianth segment.

contents as the disc grows older (Photomicrograph 2). These strands may, therefore, be

PHOTOMIOROGRAPH 2—showing the longitudinal section of the base of flower with vascular strands in the nectar secreting disc.

reasonably inferred to constitute the remnants of a more highly developed vascular tissue in an ancestral form. It is further highly probable that the vascular elements in the disc disappear completely in some members of the Proteaceæ, as in *Grevillea robusta*. Arber[5] states that organs may often persist even though the vascular traces supplying them have disappeared completely. As Wilson and Just[6] remark, "It is undoubtedly true, that in some cases at least, what may appear to be rudimentary organs have persisted with no corresponding vascular supply; such structures may, however, be really organs which can only be interpreted by a comparative study of other and closely related forms." A good instance of this seems to be met with in *Macadamia ternifolia*. We may, therefore, rightly regard the disc as a much reduced corolla in the flowers of the modern Proteaceæ, and this suggestion is further strengthened by the fact that in the place of the disc there are sometimes seen in the family four scales alternating with the perianth segments.

It is interesting to point out here that Joshi[7] regards the disc-scale in the flowers of *Stellera chamæjasme* Linn., a member belonging to the Thymelæaceæ, as a part of a much reduced corolla. This appears to be rather significant, because the families Proteaceæ and Thymelæaceæ are regarded to be probably related to each other in some way by some systematists, as Hutchinson[8] in recent years.

After the departure of the traces to the outer floral organs the receptacular stele shrinks to form a ring of vascular tissue showing a number of strands. Of these strands all, except five large ones which supply the single carpel, gradually fade away at the summit of the receptacle. The five strands of the carpel which are from the beginning quite independent of one another, arrange themselves in the wall of the gynœcium (Fig. 7) as one dorsal, two lateral, and two marginal or ventral strands. The traces for the ovules are formed higher up in the gynœcium from the two ventral strands (Fig. 7). In *Banksia* too, another member of the

Proteaceæ, the carpel has similarly five strands derived independently from the stele of the receptacle. Such a vascular condition of the carpel is regarded by Eames[9] as probably representing a somewhat specialized case derived from an original three-trace carpel, "chiefly through branching of the midrib, and by a working back of this branching tendency to the stele."

The further behaviour of the five strands of the gynœcium in the style and stigmatic regions in *Macadamia* has already been fully described in the previous paper and some of the figures in the series of transverse sections from the base upwards are reproduced here for the sake of completeness of the present account.

In conclusion the floral structure in *Macadamia ternifolia* F. Muell., may be briefly stated as follows: The flowers are probably derived from a dichlamydeous ancestry, the modern perianth representing the whorl of calyx with the usual vascular connections as in most other angiosperms and the nectar-secreting disc constituting a much reduced inner whorl of floral leaves, namely, the corolla. The vascular tissues in the disc are feebly developed, or they may be entirely lost as in some members of the family, for instance, *Grevillea robusta*. Adnation of the whorl of stamens and perianth has occurred followed by a fusion of the two sets of traces and consequent on the reduction of the corolla. The simplicity of floral construction in *Macadamia ternifolia*, which may well be true of the other members also, as revealed by a study of vascular anatomy seems best, therefore, to be regarded as a derived condition through reduction of floral parts.

S. B. Kausik.

Department of Botany,
Central College,
Bangalore,
December 27, 1939.

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[3] Eames, A. J., and MacDaniels, L. H., *An Introduction to Plant Anatomy*, New York, 1925.
[4] Brough, P., *Proc. Linn. Soc.*, N.S.W., 1933, **58**, 33.
[5] Arber, A., *New Phytol.*, 1933, **32**, 231.
[6] Wilson, C. S., and Just, T., *Bot. Rev.*, 1939, **5**, 97.
[7] Joshi, A. C., *J. Ind. Bot. Soc.*, 1936, **15**, 77.
[8] Hutchinson, J., *Families of Flowering Plants*, Vol. I, London, 1926.
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Serum Phosphatase in Pulmonary Tuberculosis

The serum phosphatase of normal persons and of persons affected with pulmonary tuberculosis has been determined (S. K. R.) by the method of Bodansky.[1] The serum phosphatase of persons with pulmonary tuberculosis is, on the average, higher than normal. Oral administration of 200 to 250 mgm. of vitamin C in the form of 10 g. of sun-dried *Emblica officinalis* pulp for ten days lowered the serum phosphatase content in more than 71 per cent. of pulmonary tuberculosis cases as compared with a decrease in 14 per cent. only in controls receiving no additional vitamin C in the form of *Emblica officinalis*.

Description	Phosphatase units (av.)	Description	Phosphatase units (av.)		Remarks
			Before exp.	After exp.	
Normal ..	1·63 (0·68–2·28)	Control (P.T.)	2·82 (1·56–4·96)	3·54 (1·52–5·04)	Phosphatase lowered in 14·3% cases
Pulmonary tuberculosis	3·95 (1·32–9·96)	200–250 mg. 'C' for 10 days (P.T.)	4·53 (1·32–9·96)	2·41 (0·92–9·36)	Phosphatase lowered in 71·4% cases

Figures within brackets indicate limits.

It is claimed that the lowered phosphatase is wholly due to the vitamin C (and/or vitamin P?) content of the *Emblica officinalis* powder which makes an improvement in the clinical condition of the P. T. patient by increased vascular resistance and other adjuvant effects. It is suggested that the determination of serum (or plasma) phosphatase be made one of the routine tests for evaluating the clinical progress of tuberculosis patients. The investigation is being continued.

M. N. RUDRA.
S. K. ROY.

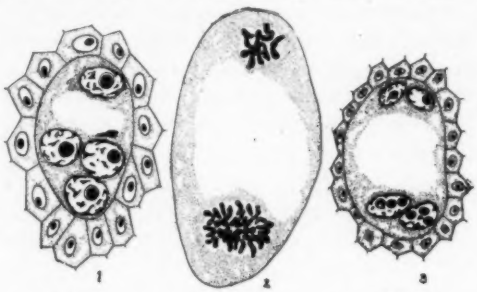
Department of Medical Chemistry,
The Prince of Wales Medical College,
Patna,
December 12, 1939.

[1] *J. Biol. Chem.*, 1933, **101**, 93.

Evidence for the Fritillaria-Type of Embryo Sac in *Tamarix ericoides* Rottl.

THE writer has recently published a detailed account of the embryo-sac of *Tamarix ericoides* Rottl., and has pointed out that it takes place according to the *Fritillaria*-type. Since then some further observations have been made and the critical stage in the establishment of the *Fritillaria*-type, which was not then available has now been met with in the preparations.

Succeeding the development of the embryo-sac showing the 1 + 3 arrangement (Fig. 1) there follows the simultaneous division of all these four nuclei and the formation of two groups of chromosomes, one at the micropylar end and the other at the chalazal end. In the micropylar group twelve chromosomes which represents the reduced number can be clearly counted. In the chalazal group a much larger number which approaches thrice that found at the micropylar end is seen. This evidently means that the group of three nuclei at the chalazal end have come together so near one another that their spindle fibres have fused and the chromosomes of the three nuclei have become indistinguishably grouped together (Fig. 2). This condition has been reported by Zabban in *Myricaria germanica*, while Mauritzon and other succeeding workers, namely, Joshi and Kajale, and Puri have not observed this stage in the several species they have worked.



Mauritzon who described the *Adoxa*-type of development in *Tamarix tetrandra* and five other species of the same genus (*T. æstivalis, A. africana, T. gallica, T. odessana* and *T. pentandra*) has also evidently not been able to follow the entire sequence of changes that accompanies the final development of the embryo-sac. After the division is over a secondary four-nucleate embryo-sac arises which has two micropylar nuclei, each with one nucleolus, and two large chalazal nuclei each of which again has three nucleoli (Fig. 3). This establishes beyond any doubt that the development of the embryo-sac in *Tamarix ericoides* Rottl. is of the *Fritillaria*-type.

I am grateful to Dr. M. A. Sampathkumaran, M.A., Ph.D., for his encouragement and guidance in the above investigation.

Y. M. L. SHARMA.

Department of Botany,
Central College,
Bangalore,
January 12, 1940.

[1] Sharma, Y. M. L., *Ann. Bot.*, 1939, **3**, 861.

Budding in *Protosiphon botryoides* Klebs

Protosiphon botryoides grows plentifully in heavily manured Canna beds of Guptar Park, Fyzabad, in the months of October and November. In early October the oval plots of this park become carpeted with a rich green growth of

this interesting alga. In the end of November the dried up clods of clay become brick-red in colour due to extensive cyst formation.

Protosiphon botryoides was collected by the present author from fields lying fallow in Hoshiarpore district of the Punjab in October 1929 and a reduced variety of it growing on walls was described by Iyengar from Madras. The interest of the present form lies in the peculiar type of budding seen in some of the specimens. Iyengar could not observe any budding in the samples he collected from Madras and he records as follows: "The budding of the green aerial portion, which Klebs recorded from the European specimens, was never observed in the Indian alga although hundreds of specimens were examined. Nor

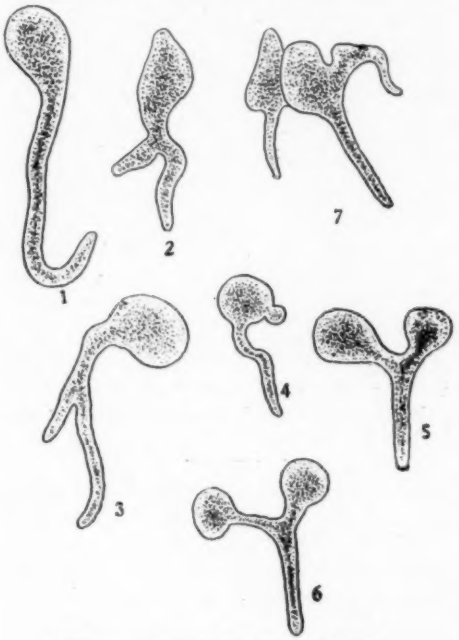


FIG. I.—*Protosiphon botryoides* Klebs.

1. A typical plant. 2 and 3. Plants with branched rhizoidal parts. 4, 5, 6 and 7. Show different stages in budding. All × 120.

was such budding ever seen in the variety growing on the walls described below." No budding was observed in the specimens collected from Hoshiarpore in 1929.

The subaerial part of the alga is usually spherical and rhizoidal part unbranched (Fig. 1). However, in some specimens branching was seen in the rhizoidal part (Figs. 2 and 3). It was observed that in some specimens bud-like protuberances were seen arising on one side of the balloon-like subaerial part (Fig. 4). A further stage in budding was seen in some specimens in which the rhizoidal part was seen bearing two globular subaerial vesicles (Figs. 5 and 6). The parent is recognized by the greater diameter in some cases (Fig. 5), while in others it is difficult to distinguish between the parent and the bud, as both are almost of the same size (Fig. 6). Individuals thus budded off usually remain attached with the parent plant for some time (Fig. 7).

It may also be noted that during the vegetative phase of this alga, budding is an important means of reproduction, especially when it grows on heavily manured soil containing plenty of nutrient material. However, when the alga is found growing in fields which are usually not well manured, budding has quite an insignificant role in the life-cycle of the alga.

M. S. RANDHAWA.

2A, Park Road,
Allahabad,
December 8, 1939.

A Note on the Algæ Collected by James A. Murray at Karachi

JAMES A. MURRAY has mentioned a few marine algæ collected by him from Manora and Clifton at Karachi in his book on the plants of Sind.[1] Murray being the earliest scientific explorer of these plants his collection is of some importance to the algologists in our country. Amongst other plants Murray has recorded the following species: *Porphyra vulgaris* Ag.; *Fucus vesiculosus* L.; *Fucus distichus* L.; *Fucus nodosus* L.; *Laminaria digitata* Lam.; *Laminaria bulbosa* Ag.; *Laminaria saccharina* Lam.; *Chordaria flagelliformis* Ag.; *Callithamnion plumula* Lyng.; *Callithamnion corymbosum* Ag.; *Chondrus crispis* Lyng. On scanning the whole list of algæ one is surprised to find that no one of his plants has been found by the recent investigators and

in fact, they are not known to occur on this side of the globe.

So far as the author is aware Murray's collection of algæ are found both at the British Museum and the Kew Herbarium. Dr. F. Borgensen[2] of Copenhagen was rather misled by Murray's collection found at the latter place. This at least has been made clear by him in the following words: "When I heard that the British Museum also possessed a large collection of J. A. Murray's Algæ from Karachi I was of course especially interested in finding out whether the northern species were found there too. This not being the case greatly increases my doubts as to whether they really live there." etc.

As some of the plants mentioned by Murray are of economic utility I visited Karachi in 1938 to find out for myself if the species were still available there. I was sorely disappointed in my search. At the same time I inquired at the Municipal Museum where Murray was a Curator, if some of his plants could be found there. There, I saw for the first time in this country, good many marine plants exhibited. They really were old but the date and the name of the collector were not on them and still more, the specimens were not what they were labelled to be. It is difficult to believe that all these plants mentioned could have existed in the locality only three score years before and now completely exterminated.

It is a loss to science that Murray's first collection is not preserved in this country so that it could now be revised like Forsskal's algæ mentioned in *Flora Ægyptico Arabica*. However, this note would serve its humble purpose if the Government and the Universities would learn better from the past and try to preserve all the original natural history specimens in this country as a national trust.

S. C. Dixit.

Wilson College,
Bombay.

[1] James A. Murray, *The Plants and Drugs of Sind*, Bombay, 1881, pp. 1–6.
[2] F. Borgesen, *A List of Marine Algæ from Bombay*, pp. 4–5, *Biologiske Meddelelser*, 1935, XII, 2, Kobenhavn.

Constitution of Sulphur Nitride

The note on the above subject in the October issue of *Current Science* (p. 473), calls for a few comments. The term "resonance" must not be mistaken for alternate structures, as the authors of the above note seem to do. After quoting the idea of Arnold, Hugill, and Hutson that sulphur nitride has structure I *with* (italics mine) the corresponding resonance structures I*a* and I*b*, the authors proceed to pick out which is the correct formula! The dipole moment of S_4N_4 as measured indicates but the polarity of the superposed state of the molecule and not that of any component state.[1, 2]

Apart from this, from a purely structural point of view, (1) it is wrong to say structure I will have $\mu = 0$, as on account of the possible free rotation about the single bonds, it will have quite an appreciable moment;[3] (3) the moment of I*b* may be due to similar reasons, the contribution of $> S = S$ being practically nil as it is a homopolar bond; (3) the formula, I*a*, if redrawn with the normally accepted valency angles, will show that there are no re-entrant angles at S atoms.

M. A. Govinda Rau.

Department of Physics,
Indian Institute of Science,
Bangalore,
October 31, 1939.

[1] C. K. Ingold, *Chemical Review*, 1934, **15**, 225.
[2] M. A. G. Rau, *Proc. Ind. Acad. Sci.*, (A), 1936, **4**, 687.
[3] ——, *Curr. Sci.*, 1934, **3**, 145.

In our note on the Constitution of Sulphur Nitride, when we assigned the structure (I*b*) to S_4N_4, we meant to say that (I*b*) was the predominant structure of the three. Regarding the actual origin of the moment and the comments of Dr. Rau, full details will be published elsewhere.

N. L. Phanilkar.
B. V. Bhide.

Chemistry Laboratory,
Sir Parashurambhau College,
Poona 2,
December 22, 1939.

Ferns of Mussoorie

We are in receipt of a paper on "Ferns of Mussoorie" by P. N. Mehra of the Punjab University, with a *Foreword* by Dr. H. Chowdhuri, Director of the **Kashyap Research Laboratory** of the Punjab University, Lahore. The author has listed 94 species including one new species and two new varieties of ferns. Such an attempt on the part of the author, to bring together in one easily accessible form, the fern flora of the locality is indeed laudable. Such local lists of special groups of plants are now in great demand. We welcome more of such local lists from systematists all over India in order to enrich our knowledge of the Indian flora.

It is our earnest desire to invite attention of such would-be authors to many important points that have to be taken into account in the preparation of such works. A thorough knowledge of the international rules of botanical nomenclature, as amended by the Cambridge Congress of 1930 and accepted by the Amsterdam Congress of 1935, is the first and foremost requisite for any systematist in India, without which, any work on Systematic Botany in India is bound to suffer considerably in the estimation of botanists outside India. The second requisite is complete knowledge of the literature, not only of the Indian but also of the other countries, dealing with the subject, because, the nomenclature of and the interpretation of species have undergone and are undergoing great changes with the increase of our knowledge. A third but not the least important, is the necessity of correlating the local collections with the authentic collections available in a fully equipped and well recognised Herbarium. For us, in India, the Herbarium at the **Royal Botanic Garden**, Sibpur, has been recognised by the Amsterdam Congress of 1935 as the chief representative botanical institution in Asia, besides the ones in China and Japan.

We have been reluctantly forced to dilate a little more than what we desired to say on this subject, as we have been observing of late, that some of the systematists have been publishing new species without any regard to the rules governing such publications. They have thus been wasting their time and energy on publishing new species which will have no value before the scientific world and we are afraid, in the long run, are likely to be discarded and forgotten.

We congratulate Mr. Mehra, the author of the *Ferns of Mussoorie*. We are also grateful for his kind reference to us in this connection. However, we have to dissociate ourselves from some of the author's conclusions as discussed below. Apart from some nomenclatorial defects, especially in the genus Polypodium, we regret to notice the utter disregard, rather to the ignorance of the author, of the International Rules of Botanical Nomenclature, in connection with the publication of his new species *Polypodium Kashyapii* nov. sp. This name is invalid and will have no status in science as it is not in conformity with the articles Nos. 18, 19, 37 and 38 of these rules, which provide, to say briefly, (1) to the existence in a well recognised institution of a type specimen on which this new species is based and (2) particularly to a latin diagnosis, followed, if possible, with proper sketches or photos of the type, without which any new species does not become valid.

Apart from the absence of this important desideratum for a new name, we have also been unable to agree with the author in regarding it as a new species. The *"certain important characters"* on which the author has based this new species, appear to us to be chiefly the *"presence of scales on the under-surface of the midrib with ovate lacerate margin and apex long drawn out, hair-like and thrown into wavy curves* (in *P. excavatum*, scales on the under-surface of the midrib are ovate or orbicular-ovate, never hair-pointed)." Secondly, the author says that the scales on the under-surface of the fronds in the new species are more numerous and hair-pointed than in *P. excavatum*.

There is a very good set of collections of *P. excavatum* (*Polypodium lineare* var. β simplex) in the Herbarium at Sibpur, especially

from Mussoorie and the surrounding localities. According to all pteridologists, including Baker and Hooker, Beddome, Christensen, Ching and others, *Polypodium excavatum* belongs to a group of ferns with the fronds having naked under-surface, i.e., without any persistent matted scales (*vide Hk. & Bk., Syn. Fil.*, pp. 353, 354). The author says that the scales in *P. excavatum* are fewer and ovate or ovate orbicular, etc., and never hair-pointed. In the collections at Sibpur, belonging to *P. excavatum*, we have failed to detect this scaly nature (large or small) on the under-surface of the fronds. In a few sheets, especially on the stipe near the rhizome, a few scattered scales whose number could be counted on the finger, are noticeable. In certain sheets a few scattered hair-like scales also by the side of the midrib towards the base of the stipe, like those pictured on p. 24 of Mr. Mehra's paper, are also present. As regards the habit, the author appears to generalise from observation made at one place only, which may be due to the nature of the habitat in that locality. We do not consider these points sufficient for specific differentiation. Further we know that the only Indian representative of the widely spread American fern, Pleopeltis, a group of ferns segregated from the heterogeneous Polypodia, having persistent peltate scales, with a dark centre, is the South Indian *Pleopeltis lanceolata* Kaulf. (*P. lanceolatum*). We also know that, according to R. R. Ching, the fronds in the young stages are densely covered with easily detachable scales which fall off with age. There will be no end to the creation of new species based upon such characters, which vary with age and are of no permanent nature. We are, therefore, apart from its invalidity of publication, inclined to consider this as only a particular stage of *Polypodium excavatum*.

The other point on which we wish to say a few words, is the nomenclature of some of these Polypodiums. It is true that Christensen has retained the name Polypodium. Under it, he has included several other groups as Subgenera. But when we consider the heterogeneous nature of the genus Polypodium and its huge size (in *Hk.f. & Bk. Syn. Fil.*, there are 390 species of Polypodium) we will be justified in splitting it up, on practical grounds, into smaller, easily recognisable groups with generic status to each. R. C. Ching has relegated all these Polypodia with simple lanceolate, shortly stipitate naked leaves and with the sori on a plexus of radiating veinlets and densely covered with detachable peltate scales when young, to *Lepisorus* (J. Sm.) Ching. According to this view, which we consider good, on practical grounds, some of the species listed in this paper become *Lepisorus Thunbergianus* (Klf.) Ching *P. linearis*), *L. clathratus* (Cl.) Ching and *L. excavatus* (Bory) Ching.

Further we consider the figure of *P. excavatum* too narrow for *P. excavatum* and it represents rather the linear leaves of *P. lineare* than those of *P. excavatum*.

The author's two varieties, var. *xerophytica* nov. of *P. lachnopus* and *P. microrhizoma*, are according to the author himself, plants occurring in open situations on calcareous rocky soil. They are, therefore, only edaphic variants of the same mother species and do not deserve a varietal rank.

V. Narayanaswamy.
K. Biswas.

Herbarium,
Royal Botanic Garden,
Calcutta,
December 5, 1939.

REVIEWS

Lehrbuch der Theoretischen Physik. Von Prof. Dr. G. Joos. (Dritte Auflage, Leipzig), 1939. Pp. 704. Price 24 R.M.

This third edition of the well-known book on theoretical physics by Prof. Joos is a marked improvement on the old editions in subject-matter as well as manner of presentation. In making these improvements the author has throughout kept in view the aim, mentioned in the *Foreword* to the first edition, that the contents of the book have been determined by taking into consideration the needs of the experimental and technical physicist.

In the present stage of the development of theoretical physics it is easy to write a book on the subject without any physics in it! It is perhaps equally easy to go to the other extreme and present all the theory needed by the experimenter in a ready-made form without going into the actual physical significance of the theory. While one could justify the statement "An ounce of experiment is worth a ton of theory" on some grounds, it is also possible to justify the opposite statement "An ounce of theory is worth a ton of experiments" on other equally reasonable grounds. Here, as elsewhere, it is the compromise between these two extreme view-points that is at all likely to succeed as the correct method of presentation for the *understanding* of both aspects of the subject. This is the method adopted in Prof. Joos' book, and it has succeeded admirably in the elementary plane to which the author has confined himself.

The brief and clear account of nuclear physics running to about 20 pages is a welcome feature of the book, and the author has taken care to include the most recent topics like the β-decay and the neutrino hypothesis, and even the mesotron. Similarly there is a short account of the theory of ferromagnetism which is of such great practical significance and has been subject recently to intensive theoretical development. The author's aim in presenting these modern topics has been that "klare erkenntnisse bedurfen nicht vieler Worte zu ihrer Übermittlung".

To write a text-book on theoretical physics is a task of great complexity. Further, to write an elementary book which is not altogether unwieldy, and which does not omit essentially important things, appears to be an art by itself. This volume before us running to 700 pages shows how this can be done successfully. No elementary course on theoretical physics which does not prescribe Joos as a text-book or a book of reference is worth anything at all.

B. S. MADHAVA RAO.

Fluorescence Analysis in Ultra-Violet Light. By J. A. Radley and Julius Grant. Third Edition. (Chapman & Hall, Ltd., London), 1939. Pp. xvi + 424. Price 22/6 net.

That the authors should be called upon to publish a third edition of this book within six years of its publication, is in itself an indication of its usefulness and interest to a wide public.

Part I of the book deals with the theory and technique of the method in a simple manner; the newer developments in the production of steady sources of ultra-violet light and in the preparation of light filters have received due attention. Part II deals with "the applications of the method to a large and varied number of ramifications of pure and applied chemistry". Indeed the scope of this method of analysis appears to be amazingly wide; and in the hands of an experienced worker, the observations can lead to safe conclusions. It may be of interest to note certain typical practical applications:—

"Fish and meat show a marked change in fluorescence due to bacterial action."

"Edible and poisonous varieties of mushrooms are detectable."

"So strong is the blue fluorescence of margarine that its presence to the extent of 15% can be detected in butter."

"The preservatives, boric acid, salicylic acid, sulphur dioxide, hypochlorites can be detected when present in 10 p.p.m."

"Lubricating oils can be tested with a view to find out their relative gumming tendencies."

"A mammoth's tusk carved to depict a woman found in some pre-historic dwellings was proved by Franz to be

the untouched work of a carver of the glacial period."

"It is claimed that polluted water containing proteins and ammonia can be readily distinguished from pure water."

"In a fatal case of calendine poisoning in which the chemical and the botanical examination gave negative results, ultraviolet light produced a marked yellow fluorescence in the intestines which was similar to that produced by the juice of calendine."

The method has yielded exceedingly interesting results in legal and criminological work relating to the identification of inks, finger-prints, stains, seals, adhesives, erased writing, forged signatures, repairs and overpainting of old pictures, drugs in body fluids, etc.

The book deals with these practical applications in an exhaustive fashion. The references have been carefully shifted and are up to date. The authors, however, very rightly point out that though "in the early days the results were so encouraging that this method was hailed as rapid, accurate .... and for many purposes, indispensable to the analyst .... maturer consideration showed that the accuracy was limited and the reproducibility dependent on strict standardisation of working conditions."

With this caution, this book may be recommended for use not only to all analytical chemists, but also to pure scientists who are interested in the interaction of light and matter.

J. C. GHOSH.

A Text-Book of Heat. By H. S. Allen, M.A., D.Sc., F.R.S., and R. S. Maxwell, M.A., B.Sc. Part II. (Macmillan & Co., Ltd.). Pp. 531–848. Price 10*sh.* 6*d.*

It is with intense pleasure that I have read the II Part of this beautiful book on Heat. It starts with the Laws of Thermodynamics and after dealing with convection and radiation, proceeds to treat of statistical methods and the quantum theory. The treatment of the First Law of Thermodynamics is lucid and adequate, and calls for no special remarks. Chapter XXIX begins to explain the Second Law—admittedly more difficult—and deals with the pioneer work of Sadi Carnot, whose argument was described by Joseph Larmor (1918) as "perhaps the most original in physical science, whether as regards simple abstract power or in respect of grasp of essential practical principles". It is well stated that whilst the first law asserts the equivalence of heat and energy the second is concerned with the 'method' by which heat can be transformed into mechanical work, and the 'direction' in which natural processes occur (p. 603).

The law is given in its negative form, and since it is proverbially difficult to prove a negative, we have to be satisfied with the assurance that the law is in harmony with our general experience (p. 604). Later on, however (p. 628), Clausius is quoted, stating the law in its positive form in the famous words: "The entropy of the world tends to a maximum", which are equivalent to Lord Kelvin's dictum: "The available energy of the world is tending towards zero" (p. 631). Now, since the available energy in the universe has not yet reached zero, one is led to conclude that either the world must have had a beginning, or its energy must be infinite, or an outsider must have interfered with the cosmic processes. But if the world's available energy is infinite, it is somewhat difficult to understand how it can tend to zero. Therefore, excluding the third hypothesis, one would say that the world is not eternal. The authors seem to have been afraid of these metaphysical depths, and have tried to save themselves by subscribing to G. N. Lewis's assertion that increase of entropy "corresponds merely to a loss of information with regard to a state of a system and is thus a purely subjective concept" (p. 815). These are dangerous words, and one wonders what would remain of physical science, if they were followed to their last conclusions. Apparently less sweeping is R. A. Millikan's remark that from the second law we cannot deduce the 'heat-death' of the universe (and its corresponding beginning), for it is not legitimate to make a sweeping generalisation from man's experience on the surface of the earth to the universe in all its parts (p. 815). Hence one would say that there are parts of the universe where, what Oswald calls perpetual motion of the second kind is not impossible (*cf.* Planck's *Treatise on Thermodynamics*, transl. by Alex Ogg, 1927, Part III, pp. 79 and ff.).

The authors state very clearly Boltzmann's relation between entropy and probability, and explain that Boltzmann's constant is to be regarded 'universal', *i.e.*, having the

same value for any system that may be chosen, no matter whether one chooses a terrestrial or a cosmic system. But if we accept Millikan's remarks, we confess we feel less confident about this asserted universality, as well as to the universality of Planck's constant and many recent conclusions of Astrophysics.

In some parts of the book one notices a very close connection with G. Castelfranchi's *Modern Physics*. (I have at my disposal only the IV Italian Edition of 1934. Hoepli, Milano.) *Cfr.* for instance the authors' treatment of Debye's Theory of Specific Heat (p. 779) and Castelfranchi's treatment. The similarity, however, may simply be due to the fact that both have made use of Debye's original *Memoir*. Yet one regrets that while Castelfranchi deals at sufficient length (pp. 430 and ff.) with the quantisation of rotary motion as suggested by Bjorrum and Schwarzschild, which throws some light on the behaviour of specific heats, our authors are silent about it.

But, in spite of these criticisms, one must end with a note of admiration for the clarity, painstaking diligence and accuracy with which the authors have acquitted themselves. Their task was not easy. They have done it well. Nothing need be said on the get-up of the book, which reaches the excellence which is usual with Macmillan & Co.

D. FERROLI, S.J.

An Introduction to Chemistry. By A. H. B. Bishop and G. H. Locket, Oxford. (Clarendon Press), 1939.

In writing this book the authors have attempted to meet an insistent demand for a sound introduction to Chemistry, and have succeeded most admirably. A text-book for high schools must be brief, clear and cheap, and the present introduction certainly satisfies the first two tests, and probably the third as well. The matter is well set out, the diagrams are neat, the plates are fine and the charts present a good bird's-eye view of the matter. To select a few points for special praise: The essentials of Dalton's contribution to the building up of Chemistry are clearly stated, and the point where his theory stops short is indicated (pp. 76–79). The various natural processes by which nitrogen in air is brought into combination with other elements are well described and the importance of these processes is explained (pp. 152–59). The interest and activity of the students is stimulated. *Cfr.* for instance, the questions on the action of nitric acid on metals (p. 146).

The Clarendon Press has done its work very well indeed.

D. FERROLI, S.J.

Quantitative Zoology—Numerical Concepts and Methods in the Study of Recent and Fossil Animals. By G. G. Simpson and Anne Roe. First Edition. (McGraw-Hill Publishing Co., Ltd., Aldwych House, London, W.C. 2), 1939. Pp. 414. Price $4.

Broadly speaking, the general Zoologist normally exhibits a natural dislike to the use of mathematical methods involving the application of complicated formulæ. The authors of this interesting book have made an earnest attempt to kindle interest in the use of statistical methods in the hope that zoologists may not 'lose sight of the purpose of his study'. Throughout the book emphasis is laid on methodology of zoology than on mathematical statistics. This volume will be of considerable help in zoological laboratories where extensive numerical data are available for study.

The volume is well got-up and we recommend the book to all zoologists.

A. S. R.

An Introduction to the Vertebrates. By L. A. Adams. Second Edition. (John Wiley & Sons, Inc., New York; Chapman & Hall, Ltd., London), 1938. Pp. 479. Price 17/6 net.

The progress of zoological knowledge in all its specialised branches has taken such enormous and rapid strides in recent years that the sphere of zoological research has considerably enlarged. Recent advances in Embryology, Palæontology and Cytology have thrown considerable light on the problem of elucidating genetic relationships and any attempt to present a comprehensive picture of animal life from a comparative standpoint is likely to meet with greater success and scientific precision in the light of these recent advances in knowledge.

In various Universities, both in India and abroad, schools of Comparative Anatomy and Embryology have been established and it is essential for higher zoological studies, to have a background of Comparative Anatomy of animals—a knowledge to be checked and

verified in the light of Embryological, Palæontological and Cytological studies.

In the wake of such remarkable progress there have appeared excellent treatises on Comparative Anatomy of Vertebrates and Invertebrates. However, there are very few books which present the subject-matter in a manner suited to the needs of a beginner in Zoology. Adams has, therefore, rendered a signal service to the students of Zoology by bringing out the book under review.

The book under review is divided into three parts. The first part gives an outline of the characteristics on which the modern system of classification of Chordates is based. This part is fairly comprehensive and gives a clear outline of the leading characters with typical examples.

The author devotes the second part of the book for a detailed description of the different systems of organs from a comparative view-point.

In part three, the author deals with the different classes of Vertebrates and gives an analysis of the anatomy and specialised characters under each class.

An interesting feature of the book is the resume which we find at the end of each chapter and the glossary at the end of the book which, we are sure, are valuable aids to the students of Zoology.

The book is well illustrated with a large number of line drawings and the get-up is very good. We have no hesitation in recommending the book to all students of Zoology.

A. N. R.

Tetrapod Reptiles of Ceylon. By P. E. P. Deraniyagala. (Colombo Museum, Ceylon), 1939. Pp. XXIX + 412 with 24 plates, 137 text-figs. and 62 tables. Price Rs. 10.

Under the auspices of the *Ceylon Journal of Science*, the first volume of the Tetrapod Reptiles of Ceylon is just published and we need hardly say that herpetologists will welcome it as a most outstanding contribution to our knowledge. The author, Mr. P. E. P. Deraniyagala has been engaged in the study of reptiles of the Island for a long time and his researches have been published from time to time in the *Ceylon Journal of Science* and in the book under review, a large part of the matter and figures are from his original papers.

In the part devoted to Introduction, the author deals chiefly with local herpetology, zoogeography, definition of reptilia, economics and classification, while in the latter part, the orders Testudinata (comprising Athecoidea and Thecophoroidea) and Emydosauria are detailed. Among the Testudinate chelonians, the genera Dermochelys, Lepidochelys, Caretta, Eretmochelys, Chelonia, Melanochelys, Testudo and Lissemys and among the Crocodiles, the genera Crocodylus and Oopholis are represented in Ceylon. Exhaustive descriptions of colour, pholidosis, osteology, food, secondary sexual characters, reproduction and some developmental stages of Testudinates are given. Out of the chelonians only the rare circumtropical Dermochelys is the athecate form, of which we knew so little till now. The animal shows certain features of primitive nature, combining at the same time, some aquatic adaptations. Of the former the lizardlike scaly covering of the young, archaic skull and pelvis, osteodermal corselet and ridges of the adult are prominent, while the streamlined body with terminal limbs, the absence of claws and the presence of web would characterise the latter. Two loggerhead turtles, Lepidochelys and Caretta occur in Ceylon and the former genus was thought to be cospecific for a long time with the Atlantic Caretta and it was first shown by the author recently that they differed considerably osteologically. In Carettidæ, the second pair of ribs is covered by the second pair of costal scutes and in Cheloniidæ, it is the first pair of costal scutes that covers. The Ceylon form is now differentiated as *C. caretta gigas* from its Atlantic congener *C. caretta caretta*. The breeding range of chelonians appears to be identical with the range of Coral growth. While some stages of the development of Lepidochelys are described, nothing is known of Caretta. Among the enemies of turtle's eggs, mention is made of monitor lizards, wild boar, dogs, leopard and man while the young fall a prey to cats, gulls, herons and crows. The hawks bill (Eretmochelys) is important because of its valuable scutes,—the "tortoise-shell" and is therefore commercially exploited. In this, the second costal scute covers three costal plates. The green turtle (*Chelonia mydas*) is prized exceedingly because it affords appetising curry. This is the only marine turtle where the young has a white plastron as in the majority of scuteless aquatic forms. Amongst others, a very interesting variation is recorded where a single adult was

scuteless and smooth-skinned. The burrow-dwelling Melanochelys exhibits variations in the corselet shape. There are two subspecies, *M. trijuga thermalis* and *M. t. parkeri* sub. sp. nov. Like the former subspecies, *t. parkeri* is also essentially a terrestrial form. Among the land tortoises, Testudo (Geochelone) is most striking by its black and yellow stellate patterns. "Its shape possibly prevents carnivores obtaining sufficient purchase for their jaws to crack this protection and also serves to store a considerable amount of peritoneal fluid which apparently assists the animal to withstand the rigors of prolonged drought, which does not cause any appreciable mortality in this species." Two races of this are represented in Ceylon. In many adults the quadrate and jugal have fused in the skull to form a great part of the zygoma and sometimes a contact between prevomer and parasphenoid appears. This tortoise buries her eggs and probably revisits them. Lissemys, the soft terrapin is monotypic with 3 or 4 subspecies, of which *L. punctata granosa* is native to Ceylon. The Indian specimens of Lissemys is indistinguishable from the Ceylon forms except in the possession of a somewhat smaller entoplastral callosity and a tendency for the corselet to ossify less rapidly than in the latter.

The two representatives of Emydosauria in Ceylon are *Crocodylus palustris kimbula* and *Oopholis porosus*, the latter of which was brigaded under Crocodylus for a long time. It is noted that the Osteodermal armature would form a more stable character of taxonomic importance. The Indian Crocodile is separated from the Ceylon swamp Crocodile and is called *C. palustris palustris*. This lives "usually if not always above the limits of salt water". The author remarks that the Indian Crocodile avoids man, but this is not always true, for man-eaters are however reported. The eustarine Oopholis is definitely a man-eater. Some stages of the development of these Crocodiles are reported and it is noted that the reproduction of Oopholis discloses embryonic phases of considerable taxonomic importance.

In dealing with the cranial bones, the author remarks that in Testudinata, postfrontals are absent and labels in his figures (17, 58, 69, 95) a bone as "postorbital" which other authors have considered to be a postfrontal. How exactly this author has come to adopt this nomenclature, it is difficult to say. At any rate in a recent book on Vertebrate skull, the chelonian bone referred to above is designated as "postfrontal". Moreover, an interparietal is also recorded in Crocodile. The choanal opening on the ventral aspect of the Crocodilian skull (p. 311, p. 330) is not indicated.

As regards the figures, by way of criticism we need only remark that it is with great difficulty we could read the magnification (fig. 26, p. 58) and labellings in some (fig. 24, p. 54; 58, p. 145; 116 (*b*), p. 307) and we hope these will be set right in the next edition.

Apart from these, the book is so crammed with information that no herpetologist could afford to be without one and rightly does Prof. J. Gardiner point out that "To the Zoologist this monograph will be a pleasure enabling him to dip deep in his search for law in correlation of structures and habits while the naturalist will gain all he desires". While congratulating the author, we have no hesitation in recommending it to every student of Zoology. L. S. R.

Study on the Legal Position of the Illegitimate Child. (Series of the *League of Nations* Publications IV.—Social Questions, IV, 6, Geneva), 1939. Pp. 27.

Whatever the **League of Nations** might or might not have achieved in the field of the political life of humanity, it has certainly rendered meritorious service in the cause of the solution of many outstanding social problems, both in the matter of creating right sort of public opinion by offering the reading public detailed information regarding the nature and solution of such problems in the different nations of the world as well as in more directly using its prestige in moving various governments to take definite measures. Of these social problems, those connected with children, naturally claim our peculiar attention. The volume before us is concerned with one of the problems concerning children. In most societies, there are large groups of persons towards whom, the society has assumed rather cruel attitude. Illegitimate children are, perhaps, the worst and the most undeserved sufferers from this attitude. The work under review gives an historical outline of the social and legal aspects of illegitimacy and then presents the contemporary legal position of the illegitimate child and its claims against its father and mother. Further, we are told,

how official documents in various countries have been tried to be reproduced without indicating illegitimacy. We are also told what is being done regarding guardianship of such children. Protection of mothers of such children is a relevant topic as it affects the health and well-being of these children and is specially treated in one chapter. Finally, a large amount of statistical information regarding the percentage of births in different countries and infant mortality rates among illegitimate children is summarised and also presented in the appendix.

An illegitimate child may be described as one born or probably conceived out of wedlock. Such a child may be born to an unmarried woman or to a widow, to a concubine or to a prostitute. The last category of illegitimate children may be left out of consideration both because there are many special circumstances as well as because the number is likely to be small. Illegitimate children born to concubines have always been treated by society with a little more consideration than other illegitimate children. It seems that the various disabilities, social and legal, against illegitimate children are intended to preserve the sanctity of the marriage tie; but in practice it is clear that the social attitude towards such children gave a sort of a licence to the male for extra-marital sex-intercourse with impunity. If such attitude protected the marital tie any time, to-day, at least, when we find that in some countries illegitimate births constitute 50 to 70 per cent. of all births and in many countries they constitute 20 to 30 per cent., it can hardly be said to have any influence on marriage tie.

That illegitimate children have a very bad time of it from their very birth—nay, even in the pre-natal condition—is clear from the high infant mortality rate, higher by 50–100 per cent. than the infant mortality rate among the other children. And this when the progress of legislation and provision of communal care on behalf of illegitimate children has gone so far that the present position is summarised in the book under review in the following words: "In many countries, the position of illegitimate children is coming to resemble more and more closely that of legitimate children." To soften the effects of the social stigma attached to illegitimacy, legitimation is the procedure allowed and adopted in many countries; maintenance rights are guaranteed in most and retention of the child with its mother is attempted in many countries. Nevertheless the circumstances of illegitimacy are such that in a number of countries it is found necessary to appoint official guardians for such children and even to place them in families. This shows that in these countries, and even in others, the distinction between the legitimate and illegitimate children remains marked though the actual conditions of living are ameliorated. The problem, it appears to the reviewer, is not a problem merely of amelioration but one that requires a radical treatment.

The actual number of illegitimate children being born every year must be very large indeed and the enormity of the problem would have been more poignantly brought to the notice of the reading public if these absolute figures were presented. In one of the previous publications of the same organization we read that in Germany alone in the year 1930 there were as many as six lacs of illegitimate children under communal care. The annual placements of illegitimate children in various countries would have enabled us to understand the extent to which the social attitude towards them is changing but the figures are nowhere given in the book. The procedure adopted in this book of presenting the material under various categories is not conducive to a proper understanding of the problem and the authors of the book themselves are at a loss to understand the causes of the varying rates of illegitimacy in different countries. If it is borne in mind that even the concept of illegitimacy is not uniform in all the countries, it will be readily admitted that the older procedure of presenting the material by countries rather than by these categories is decidedly better. The annual number of legitimations taking place in each country, if presented, would further enhance the understanding of the problem. In short, the reviewer is sorry to see that though much of the material is valuable there is no attempt to present an organic picture with a view to help radical understanding of the problem.

G. S. GHURYE.

THE CENTRAL BOARD OF IRRIGATION IN INDIA

THE *Annual Report* (Technical) of the **Central Board of Irrigation**, India, 1937–38, is a highly instructive publication, giving in outline, the various lines of investigation in connection with irrigation problems that are being tackled at the different hydraulic laboratories in India. The *Report* shows that no new research station has been opened during the course of the year under review. The existing stations are:—

1. *Central Research Station at Poona.*
2. *Punjab Research Station at Lahore.*
3. *Bombay Research Station at Poona.*
4. *United Provinces Research Station at Lucknow.*
5. *Sind Research Station at Karachi.*

The work carried out by these Research Stations cover a wide range of subjects and the discussions provided by the periodic meetings of the workers in these fields are both refreshing and instructive. The interchange of ideas between scientists and engineers which the meetings of the **Central Board of Irrigation** promote, has got one great advantage, in that they give to the scientists a practical outlook and to the engineers a scientific bent of mind.

In going through the various *Annual Reports* of the Central Board for the last few years of its existence, one is struck by the fact that more and more attempts are being made to tackle problems of flood and river control by means of scale model works. The *Central Station* at Poona has been carrying out these experiments for the last few years. In the year under review experiments in river models have also been instituted by the *Punjab Irrigation Research Institute at Mallikpur River Model Station.* These models were two of a series of experiments carried out in connection with the Haveli Project. The river models specially for alluvial rivers are in the early stage of their development and it will require careful and patient study by scientists and engineers to make them yield useful quantitative information for future guidance. The construction, manipulation and interpretation of two dimensional models such as that of a weir section for scour downstream or for position of the standing wave are comparatively simple and have been more or less standardised. The experimental results can be safely interpreted as their peculiarities and limitations are well known. For such three dimensional models as those of falls for bed and side scour, the construction, manipulation and interpretation are more difficult, though with the accumulation of more data, the interpretation of these results are becoming easier and reliable. But for river models the main difficulty is the correct reproduction of the movement of silt both on the bed and in suspension. For Northern India rivers, this difficulty is not so acute as the silts here are more or less incoherent sand and their quantities are not very great. But rivers in Bengal, Bihar, Assam and Orissa bring in huge quantities of silt and their qualities, specially those of the rivers that fall in the Gangetic Delta are colloidal. If this fundamental difference between the silt carried by the two systems of rivers in India, those of Northern India and those of the Gangetic Delta is realised, then it will become easy for the scientists and the engineers who deal with models and utilise their results to practical ends, to understand that the results derived from experiments on Northern India rivers will not apply directly to the rivers in the Deltaic regions. This difficulty is already being felt by engineers in Sind who have, up till now, tried to apply Lacey to a system of canals that carry quite an appreciable proportion of very fine colloidal clay in the bed and in suspension. In Sind a number of canals designed on Lacey had silted up badly and this was only to be expected as Lacey is supposed to hold good for canals which carry incoherent alluvial sands on the bed. Thus the application of any theory or equation derived for Northern India river conditions to the deltaic rivers of Bengal, Madras or Sind is bound to lead to costly failures. Similarly, the experience gained from the working of scale models of rivers of Northern India will not be directly applicable to rivers in Bengal or Madras.

Central Research Station, Poona.—This station has in its programme a long list of model experiments mostly in river training. The summaries show only one experiment on silt exclusion and another on falls. Among the river models there is mention of a model of the River Ganges at Hardinge Bridge. The informations supplied in the summaries are too meagre to enable the reader to form any clear idea about the

details of these experiments. One wonders if the effect of colloidal silt which is so prevalent in the river Ganges has been taken account of in the model.

Punjab Irrigation Research Institute, Lahore.—The Institute deals with almost all aspects of irrigation, from river training to reclamation of alkali soils by molasses. The poor results obtained with molasses in the Punjab as compared with the very satisfactory results obtained in the United Provinces make one wonder if the two types of alkali soils were the same in both the Provinces. It appears that an extensive series of model experiments on tube wells had been carried out in the Institute. The results, although indicated only briefly, appear to be highly instructive.

Bombay Research Station, Poona.—This Station has been mainly busy with waterlogging and drainage problems in the sugarcane areas of the Deccan Canals. Experiments on reclamation have also been carried out.

United Provinces Research Station at Lucknow.—This Station has now got a small flume for carrying out experiments in two dimensional models such as scour below falls. A number of models on different scales had been experimented upon. The silting of Sarda Canals Main Line and the control of silt entry at the head by means of regulation had been the subject of another investigation at this Station. The methods of sampling suspended silt from the river and the canal adopted in this experiment do not appear to be satisfactory. The authors are requested to see that these samples are representative and reliable.

Sind Research Station at Karachi.—It appears that this Station has increased its activities in the direction of model experiments mainly on falls and scour below falls. They are more or less on the standard lines as carried out in other stations. Lacey's Silt Theory received some attention here also but as was pointed out before, it did not lead to any useful conclusion.

In the agenda for the eighth meeting of the Research Committee of the Central Board of Irrigation held in Simla from the 5th to the 9th July 1939, there are a number of interesting items discussed.

One of these was the establishment of a Central Research Station for Irrigation. The arguments that had been advanced for or against the establishment of such a Station were many. But one point seems to have been missed by most of the speakers that irrigation and river conditions are different in different parts of India and as had been pointed out before the results obtained in Northern Indian conditions will, in most cases, not be directly applicable to deltaic conditions in Bengal or Madras. Under these circumstances it appears regional Research Stations will be more suited to Indian conditions than a Central one.

OBITUARIES

P. V. MAYURANATHAN
(1893–1939)

MR. P. V. MAYURANATHAN, who died of heart failure on December 1, 1939, was born on March 4, 1893 not far from Palghat, where he was educated till he passed his Intermediate examination. He then entered Presidency College, Madras, where he studied botany under Prof. Fyson, taking his B.A. degree in 1918. After teaching for a time in the Venkatagiri Raja's School, Nellore, he joined the staff of the Government Museum, Madras, in August 1920, taking charge of the Botanical, Geological, Anthropological and Economic Sections, the Anthropological Section being separated later under its own Curator.

In view of the multifarious duties imposed upon its Curator, it is not surprising that the Botanical Section had come to be badly in need of reorganisation. The first necessity was the building up of a reserve herbarium collection on which to draw for exhibition purposes, work on which he entered with enthusiasm and continued till his death. Special attention was naturally paid to local plants, resulting in his preparing in conjunction with Mr. Barnes, of the Madras Christian College, *The Flowering Plants of Madras City and its Immediate Neighbourhood*, published as a Madras Museum Bulletin in 1929.

Owing to the difficulty of dealing with succulent plants from herbarium specimens only, a collection of living specimens of the Indian species of *Caralluma* was made and an account of them was published by Mr. Mayuranathan and myself in 1931. This led him to attempt a similar study of the succulent Euphorbias of India on

which he was still engaged at the time of his death, progress being dependent on their slower rate of growth. He was also much interested in the histories of introduced weeds and other plants, to the study of which his most noteworthy contribution is a paper on *The Original Home of the Cocoanut* based on allusions in Sanskrit literature and Indian tradition as well as on botanical evidence. This was published in the *Journal of the Bombay Natural History Society* in 1938.

The need to deal effectively in the Museum with the major ecological aspects of South Indian botany necessitated the preparation of a classification of the principal types of South Indian vegetation. This he began in collaboration with me about a couple of years ago. The extensive knowledge he had acquired during his various collecting expeditions formed the basis of this work. A scheme of classification was formulated and submitted to several other botanists for criticism, since it presents problems in which the widest collaboration is likely to be helpful. Its main lines seem to meet with general acceptance, but some details need modifying and this has yet to be done. His untimely death is a great loss. F. H. G.

V. N. RANGANATHA RAO, L.Ag.

BY the sudden death of Mr. V. N. RANGANATHA RAO, L.AG., Economic Botanist, on the 2nd December 1939 after a brief illness, the Mysore Agricultural Department lost a very devoted and successful plant-breeder. The late Mr. V. N. Ranganatha Rao comes of a family which has rendered meritorious services to Mysore. He was the nephew of Mr. Vijendra Rao, Chief Secretary to Dewan, Sir K. Seshadri Iyer. He had his agricultural education in the Nagpur Agricultural College and his training in plant-breeding under Dr. R. J. D. Graham, formerly Economic Botanist, Central Provinces, now Professor of Botany at the University of St. Andrews. He was also a pupil of Mr. R. J. Allen, C.I.E., now Commissioner of Agriculture, Baroda. Mr. Ranganatha Rao had the greatest admiration for these two professors and up to the last day he was in correspondence with Dr. Graham who had a high regard for his old student.

Mr. V. N. Ranganatha Rao spent most of his service in plant-breeding work on cottons in Mysore. The results of his work are of far-reaching benefit. He has evolved several strains of Asiatic cottons for the black cotton soil area of nearly 70,000 acres in the Chitaldrug District. Of these (*Herbaceum* 190) better known as H. 190 is the best. It is a cross between *Gossypium herbaceum* and *Gossypium arboreum*. Its cultivation is extending fast as it has a high yield, a ginning percentage of 30, a staple length of almost 1 inch and a spinning capacity of over 30's warp counts and a silky feel. Other strains evolved by him for the black cotton soil area which are under statistical tests are Strain 19 and Nadam-like. These are also gaining in popularity with the raiyats. To drive out of cultivation the short staple *Bokda* cotton which was seeking a habitation in Chitaldrug on account of its high ginning percentage, he evolved a cross between *Gossypium Cernum* and *Gossypium obtusifolium* (Nadam). Though somewhat wanting in silkiness his *Cernum-Nadam* crosses are heavy yielders with medium staple, a very high ginning percentage of 37 and spinning capacity of 25's warp counts. These are found useful on account of wilt resistance inherited from the *Cernum* parent and very clean for picking.

In evolving new strains of *hirsutums* Mr. Rao has also rendered meritorius service. The scope for cultivation of New World Cottons in the red sandy loams of the Maidan Districts in Mysore is very great. Mr. Rao obtained a good cross between Mysore Doddahatti (acclimatised Upland cotton known to the trade as Banavar cotton) and a tree cotton answering the description of a Peruvian. This cross, M.A. II, with a ginning percentage of 30, spinning capacity of 25 to 30's warp counts and a staple length of 7/8 inch is a most prolific yielder under Mysore conditions of all the New World Cottons grown in India. Individual plants with over 100 bolls are not uncommon. He was engaged during the last three years in evolving an Asiatic cotton with wilt resistance and a high ginning percentage. His crosses now in row tests are H. 190 × Cernum Nadam 4–5 and Strain 19 × Cernum Nadam 4–5. He has also made new crosses to further increase the lint length and ginning percentage of M.A. II which has a great future in Mysore.

Mr. V. N. Ranganatha Rao's death has deprived the Mysore Agricultural Department of a very able plant-breeder who has rendered meritorious service to his State.

CENTENARIES

Baker, George (1540–1600)

GEORGE BAKER, an English surgeon, was born in 1540. He was a member of the Barber Surgeon's Company and was elected its master in 1597. He had considerable practice in London and was the family physician of the Earl of Oxford.

His Publications

His first book, the *Composition or making of the most excellent precious oil called oleum magistrale and the third book of Galen; a method of curing wounds and of the errors of surgeons* saw a second edition in 1599. His *Antidotarie of select medicine* was published in 1579.

Advocacy of the Mother-Tongue

Baker was an enthusiastic defender of the use of the mother-tongue for writing books on learned subjects. He translated many treatises from Latin. He advocated free translation. "If it were not permitted to translate but word for word, then I say, away with all translations".

Technical Terms

At the same time he insisted on the adoption of Latin technical terms, a fact which must be of value to the controversy that now prevails in our land over the "coining" of technical terms in the mother-tongue. "As for the names of the simples, I thought it good to write them as they were."

Walter, Thomas (1740–1789)

THOMAS WALTER, an early American botanist, was born in Hampshire, England, in 1740. He was a man of considerable education. As a young man he emigrated to South Carolina and lived throughout the revolutionary period and its turbulent internecine local warfare the life of a gentleman farmer on the banks of the Santee River.

Flora of Caroline

Throughout his short life, botany was his absorbing avocation. It has been stated that it was his "devotion to the cause of science (that) led him to the wilds of Carolina". It explains his assiduous study of the flora of Carolina, his painstaking analysis of a majority of the species sought out, his laborious preparation of an erudite flora of the region and the formation of a botanical garden upon his estate.

Flora Caroliniana

Walter's *Flora* (1788) is a volume of 263 pages, describing more than 1,000 species distributed among 435 genera. More than 200 of the species and 32 of the genera were described as new. It was based upon studies of specimens collected within a radius of fifty miles from his plantation. The nomenclature follows the binomial system.

Walter Herbarium

It was John Fraser that published the *Flora*. Fraser carried to England not only the manuscript of the *Flora* but also the Walter Herbarium. The herbarium remained in the hands of the Fraser family till 1849, when it was presented to the Linneen Society of London. In 1863 it was purchased by the Natural History Section of the British Museum for 15 shillings.

Walter died at his home, January 17, 1789.

Haygarth, John (1740–1822)

JOHN HAYGARTH, an English physician, was born at Garsdate, Yorkshire, in 1740. He graduated M.B. at Cambridge in 1760 and immediately thereafter became physician to the Chester Infirmary. In 1798 he retired from this occupation and established practice at Bath.

First Advocate of Isolation Hospitals

Haygarth devoted considerable thought to fevers and was one of the first to distinguish them by their periods of incubation. In a paper entitled *Observations on the population and diseases of Chester in* 1774, published in the "*Philosophical transactions*" of 1778 he advocated the removal of persons seized with fever to separate fever-wards, spacious and dry. His rules for such fever-wards and for preventing the spread of infection in private houses were of a pioneer nature.

Advocates Inoculation

In 1784, that is, even before Jenner's discovery of vaccination, he published *An enquiry how to prevent smallpox* and in 1793 he published in two volumes *A sketch of a plan to exterminate the causal smallpox, and to introduce general inoculation.*

His Publications

Haygarth was a prolific writer; he wrote many other books and contributed several papers to scientific journals. His *Synopsis pharmacopœiæ Londoniensis* (1810) and his tract *On the imagination as a cause and as a cure of disorders of the body* (1880) are of particular interest.

Haygarth died at Bath, June 10, 1822.

Cleland, James (1770–1840)

JAMES CLELAND, a Scottish statistician, was a native of Glasgow. He began life as a cabinet-maker and became superintendent of public works in London. His name is of interest to-day as that of one who was the first official Census Commissioner in the United Kingdom. In 1819 he took the first census of Glasgow and repeated the work in 1821 and 1831. This gave him an intimate knowledge of Glasgow and led to his writing several books on the city. The two of them which are of historical interest to a student of statistics are the *Enumeration of the inhabitants of Glasgow* (1832) and the *Historical account of bills of mortality and the probability of human life in Glasgow and other large towns* (1836).

S. R. Ranganathan.

ASTRONOMICAL NOTES

Planets during February 1940.—During the last week of February and the first week of March 1940, the five brightest major planets visible with the naked eye, will be well placed for observation in the evening sky towards the west of the meridian and will lie along the ecliptic within 40° of each other. Both Mercury and Venus can be seen low down in the west about sunset; the former reaches greatest elongation from the sun (18° 9′ E) on February 28 and will appear at that time as a star somewhat reddish in colour and slightly brighter than magnitude zero. Venus continues to move slowly eastward increasing its apparent distance from the sun and will be a conspicuous object in the western sky in the evenings. On February 20, there will be an interesting conjunction of the planet with Jupiter, the two being just over a degree apart at the time. Another conjunction that can be observed with interest will be that of Mars with Saturn on February 13. During the month, the moon will be in conjunction with planets as follows: Venus, February 11; Jupiter, February 12; Mars and Saturn, February 14; and Uranus, February 15.

Comets.—Periodic Comet Faye was re-discovered by Jeffers at the Lick Observatory on November 3, 1939; the object is reported to have been faint (about the 16th mag.) and diffuse with a small nucleus. The last apparition was in 1932, the period being 7·4 years. The comet is due to pass perihelion on April 23, 1940. Information has also been received (U.A.I. Circ. 798) of the discovery of a new comet by Friend at Harvard on November 4, 1939. The comet was, at the time, in the constellation Herculis, and moving in a south-easterly direction. A parabolic orbit has been computed by Maxwell and Grosh which shows that the object passed perihelion on November 6. The comet appears to have become as bright as the 8th magnitude on November 10.

A Recurrent Nova.—The star U Scorpii was discqvered to be invariable by Pogson at Madras on May 20, 1863. Subsequent observations showed that the star was without doubt, a nova. Recently Mrs. Helen L. Thomas has examined the star on 1508 photographs taken at Harvard between 1891 and 1939, and finds (U.I.A. Circ. 802) that the nova was at maximum (magnitude 8·8) on May 12, 1906 and again on June 22, 1936 when its magnitude was 8·8. During the intervals between maxima the star appears to have been fainter than the 17th magnitude.

T. P. B.

MAGNETIC NOTES FOR DECEMBER 1939

THE magnetic conditions during the month of December 1939 were slightly more disturbed than those during the previous month. There were 3 days of *Moderate* disturbance (international character 2), and 18 of slight disturbance (character 1). Quiet days numbered 10 during the month.

Dates of the month	Quiet days	Disturbed days	
		Slight	Moderate
December 1939	2, 4, 14, 17 18, 19, 25, 29, 30, 31	1, 3, 5, 6, 8–13, 15, 16, 20, 22, 23, 24, 26, 28	7, 21, 27.

Seventh was the most disturbed day during the month and 18th the quietest. The above table shows the distribution of days of different characters during the month.

Only one moderate storm was recorded at about 20½ hours G.M.T., on the 6th December as against a moderate storm during December of last year. The mean monthly character for December 1939 as determined at Bombay is 0·77 as against 0·97 for December 1938.

M. R. RANGASWAMI.

The Observatory,
Colaba, Bombay,
January 8, 1940.

SCIENCE NOTES AND NEWS

Mother and Child Combinations of Blood Groups and Blood Types in Calcutta.—A paper relating to the study of blood groups was read at the ordinary meeting of the *Royal Asiatic Society of Bengal*, held on Monday, January 1, by Dr. Eileen W. E. MacFarlane. The author has examined bloods from 252 matching pairs of mothers and babies. "Among these 127 were homospecific and 125 were heterospecific. There is no significant difference in frequency of premature births ncr in weight at birth between these two groups. Agglutination time of agglutinin B in cord blood is similar to that in adults but for A it is almost twice as long. Only about one-third of the infants have demonstrable agglutinins at birth. Sub-group A_2 is found in between 2% and 3% only of Indians in Calcutta. One hundred matching pairs of mothers and babies were typed for M, MN and N. Among them 56 were homotypic and 44 heterotypic. No exceptions to the expected possible combinations of mother-child blood types or blood groups were found. The proportions of the blood types were found to be of the same order as reported for Calcutta by previous workers, with somewhat more of MN and less of type M. The Calcutta Muslims examined resemble in their blood group proportions the up-country Khatris and not the rural Bengali Muslims."

* * *

"Anastomoses between the Rectal and Uterine Views forming a connection between the Somatic and portal venous system in the Recto-uterine pouch," E. G. WERMUTH, *Jour. Anat.*, 1939.—In this important contribution, the author has given a description of the various anastomoses between the uterus and the rectum. These anastomoses between the portal and somatic venous systems were hitherto unknown. The significance of these anastomoses, in normal and pathological conditions, is discussed with special reference to the spread of infection from the uterus and parametrium towards the portal vein. It is suggested that in portal congestion these anastomoses are of greater importance than the circumanal anastomoses.

* * *

Fumigation of Rat Burrows as an Anti-Plague Measure.—Health Bulletin No. 21 (By Lt.-Col. W. J. Webster, M.C., I.M.S.; Manager of Publications, New Delhi, Second Edition, 1939, Price 2*as.* or 3*d.*) gives full details for conducting fumigation of rat burrows by hydrocyanic acid gas which is now recognised as the fumigant of choice as far as the lethal effect on rats and fleas is concerned. Experiments have been carried out in the Cumbum Valley in the Madras Presidency and also at Bombay and Lahore under the auspices of the *Indian Research Fund Association*, the Travancore Durbar and the Bombay and Punjab Governments and it has become evident that "such products as Calcid, Cyanogas 'A' dust and Cymag are powerful lethal agents for rats and rat fleas and that they can be successfully applied to rat burrows and that they are, therefore, valuable weapons in the fight against plague." "The work in Madras Presidency indicates that to maintain a steady low level of rat-population in villages fumigation should be repeated at least once in three months. It is suggested that if this were continued over a period of three years there might be a prospect of eradicating plague from endemic foci." The bulletin gives valuable information on the treatment of cyanide poisoning, chemical tests for the detection of hydrocyanic acid, etc.

* * *

International Trade in Certain Raw Materials and Foodstuffs, 1938.—A new volume entitled *International Trade in Certain Raw Materials and Foodstuffs by Countries of Origin and Consumption*, 1938 (Ser. L.o.N.P., 1939, II. A.22, 178 pp., 6/-), which is the fourth of its kind, has just been published by the Economic Intelligence Service of the *League of Nations*. It gives an account of the movement from one country to another of the commodities dealt with.

This volume contains provisional statistics for 1938 as well as revised and completed statistics for 1936 and 1937 relating to 38 commodities. These commodities include wheat, sugar, rubber, wood in various forms, hides, wool, cotton, silk, iron and steel, copper and motor spirit. The number of importing countries covered by the various tables is 125, as compared with 42 in the first volume. The statistics are thus practically world-wide, the 125 countries dealt with representing 98% of the total world trade.

The object of this volume is to show the sources from which countries do in reality obtain their raw materials and foodstuffs. The trade returns published by many countries fail to furnish this information or they indicate some intermediate country from which the goods have been sold or consigned and not the country from which they originated.

* * *

Methods for the Detection of Toxic Gases in Industry.—Four new leaflets in the series describing methods for determining low concentrations of dangerous gases which may occur in the atmosphere in industrial works have now been published by H.M. Stationery Office for the Department of Scientific and Industrial Research.

(1) Leaflet No. 8 describes a method whereby concentrations of *Phosgene* down to 1 part in 1,000,000 may be quickly estimated by drawing a sample of the atmosphere through a test paper and comparing any stain so obtained with a standard colour chart. (2) Leaflet No. 9 describes a method whereby concentrations of *Arsine* down to 1 part in 250,000 may be quickly estimated by drawing the atmosphere under test through a test paper and comparing any

stain so obtained with a standard colour chart. (3) Leaflet No. 10 describes a method whereby concentrations of *Chlorine* down to 1 part in 1,000,000 may be quickly estimated by drawing samples of the atmosphere through a bubbler containing a solution of a suitable chemical and comparing the depth of colour developed with a series of standard colours. (4) Leaflet No. 11 describes a method whereby concentrations of *Aniline Vapour* ranging from 1 part in 5,000 to 1 part in 200,000 may be quickly estimated by a refinement of the bleaching powder test, which has been made quantitative by comparing the colours obtained at known concentrations with a series of standard colours prepared from a dye.

A pamphlet describing the complete series of gases and vapours to be covered is obtainable on application to the Secretary, Department of Scientific and Industrial Research, Teddington, Middlesex.

* * *

Wood and Charcoal as Fuel for Vehicles.—A contribution to the literature on alternative fuels for vehicles has been issued by the *National Research Council of Canada* (Ottawa, 1939, pp. 23, price 25 cents) under the title "Wood and Charcoal as Fuel for Vehicles". This mimeographed publication contains a list of recent articles on this subject that have appeared in English, French, German and Italian books and periodicals, and gives brief accounts of their contents. The articles reviewed deal with test results, industrial performance and design of equipment, and show the present economic status of vehicles driven by gas from wood and charcoal.

It is pointed out in the publication that France has about 4,400 of these vehicles, Germany and Italy about 2,000 each, England very few. The use of such vehicles in Germany and Italy will be restricted by Germany's status as an importer of wood, and the inability of Italy to produce sufficient charcoal to drive more than 6,000 vehicles. Italy and France both have regulations aimed at increasing the number of wood-gas-burning vehicles.

* * *

Handbook of Empire Timbers is a publication, compiled by the *Forest Products Research Laboratory* of the Department of Scientific and Industrial Research. It contains up-to-date information on the properties, uses, and supplies of nearly 100 timbers of Empire origin that are now being offered in the home markets, and gives strength values, saw specifications, and kiln schedules appropriate to the different timbers dealt with. Much of the information has accrued since the Empire Marketing Board issued a Handbook with the same title in 1932. The pamphlet is priced 3*sh.* 9*d.* (post free) and can be had from H.M. Stationery Office, London, W.C. 2.

* * *

The Rothamsted Experimental Station Report, 1938.—The yearly account of the activities of the Rothamsted Experimental Station is addressed to two sections of the agricultural readers: those mainly interested in farming the land or advising in direct practical problems, and the scientific specialists whose highly technical and often rather intangible researches will form the basis for the practical advances of the future. For farmers the main field covered is crop production including manuring, cultivation and soil improvement, and plant disease caused by insect, fungus, and virus agents. The section dealing with a large body of data on wheat-growing, particularly in relation to the growth of consecutive crops of wheat on the same land, is of great value at the present time. The effects of manures and of previous system of cropping are summarised, and the existing knowledge on the control of Take-all disease, one of the most serious menaces in intensive wheat cultivation, is set out. A further pressing problem in a period of exhaustive cropping will be the maintenance of organic matter in the soil, and preliminary experiments on the use of surplus straw and of prepared dust-bin refuse from the towns are reported. The section dealing with the action of fertilisers contains a summary of the work carried out by the Rothamsted staff and their collaboration at outside centres in the past seventeen years. This work covers a wide range of crops and soils and is always associated with soil analysis in order to examine the value of various chemical methods proposed for the prediction of manurial requirements. In the Statistical Department methods of field experimentation and the treatment of the results are being further developed with a view of linking together high precision and economy of work in the field. A study has been made of the handling of agricultural data obtained by survey or questionnaire methods, this is in effect the systematisation of a large body of experience as distinct from the interpretation of numerical data derived from an experiment. The report contains a series of short summaries covering the current work of the laboratory departments, and includes abstracts of the 97 scientific and technical papers published during the year.

* * *

Jute Grading Experiments.—With a view to train jute growers in selling their produce in graded form, an interesting experiment is now being carried out by the *Indian Central Jute Committee* at Kendupatna, Cuttack (Orissa). Over 300 growers have joined a Co-operative Jute Sales Society, set up by the Development Department of the Government of Orissa and financed by the *Indian Central Jute Committee*. Instructions are given to grower-members in the principles of jute grading, by demonstrating the methods of assorting and the qualities that go to make up each work. The growers are evincing keen interest.

* * *

Coal Mining in India, 1938.—A record output of coal and a record number of persons employed in coal mining coupled with a small general increase in the wages paid in practically all the coal-fields, and high prices for coal at the beginning of the year, followed by a decline towards the end, are some of the main features of the mining industry in India, to which attention is drawn in the *Annual*

Report of the Chief Inspector of Mines in India for 1938, just published.

The output of coal in 1938 was over 25,250,000 tons of a declared value of Rs. 9,50,00,000 representing an increase in the output of a little less than 3,000,000 tons as compared with 1937, and an increase in value of Rs. 2,50,00,000. There were increases in output in the Jharia, Raniganj, Karanpura, Pench Valley and Assam coal-fields and decreases in the Bokaro and Giridih ones. The number of coal mines worked was 665, and the number of metalliferous (including stones, etc.) mines at work was 1,288 in the year.

Despatches of coal amounted to over 21,000,000 tons. In addition, nearly 1,500,000 tons were consumed on the collieries. The quantity of coal used for coking at the collieries was nearly 1,500,000 tons and 901,000 tons of soft coke and 104,000 tons of hard coke were made.

Coal exports amounted to nearly 2,250,000 tons, as compared with over 1,750,000 tons in 1937.

There was a decrease of about 34,000 tons in the output of manganese ore, the figures of production being 766,000 tons, valued at about Rs. 1,25,00,000, as compared with 800,000 tons valued at about Rs. 2,75,000 less in 1937. Output of iron ore also declined from 1,587,000 tons, valued at Rs. 27,50,000 in 1937 to 1,421,000 tons valued at Rs. 27,00,000.

* * *

***Ulla* Grass for Paper-making.**—Investigations on the utilisation of *Ulla* grass (*Anthistiria gigantea*), found in abundance in the United Provinces, for the production of wrapping and packing papers, have been completed at the *Forest Research Institute*, Dehra Dun. These investigations indicate the possibility of manufacturing, from *Ulla* grass, packing and wrapping papers which will approach in quality, the imported imitation *kraft* papers and which will be superior to the brown wrappings imported into or manufactured in this country. The development of both large- and small-scale industries and the rise in the economic standards in the country point to an increasing demand for packing and wrapping papers of the *kraft quality*.—("*Indian Forester*," January 1940, pp. 47.)

* * *

The 75,000-pound **Antarctic Snow Cruiser** devised by Dr. Poulter and owned by the Research Foundation of the Armour Institute of Technology, is now on its way to the South Pole. Rear Admiral Richard E. Byrd is in command of the Cruiser and this is the third time that **Messrs. Bausch & Lomb** has been called upon to supply much of the optical equipment.

The cruiser is equipped with bunks, galleys, laboratories, machineshop and dark room and will carry a plane on its back, thus providing a movable base for the operation of field parties. The research programme laid out for the scientific members, according to a press note issued from Rochester, include: "Geomagnetic studies, astronomic observations, a renewed attack on unknown sectors of Antarctica, detailed surveys, meteorological observations, radio tests, metabolism studies, seismic prospecting, biological and zoological collecting, and geology, will occupy the time of some twenty scientists and their aides. The expedition has had the aid of a group of 30 scientists of the *National Academy of Sciences* in planning the programme for the United States Antarctic service.

"Spurred by the increasing number of claimants to slices of the Antarctic and its future possibilities as an aerial, meteorological and observational base, the United States Government has voted funds to make a thorough survey of this territory and a comprehensive study of its resources. The American claims which are undisputed will add a domain vaster than Alaska, afford protection for our whaling interests, and give us an opportunity to establish observatories for long-range forecasting of weather.

"Coal resources, second only to those in the United States, together with oil, copper, nickel and tin, are believed to await the development of Antarctica.

"Only 575 nautical miles separate the tip of South America from Palmer Land in the Antarctic, an easy plane flight, lending point to our extension of the Monroe Doctrine clear to the pole."

* * *

South Indian Science Association, Bangalore.—The Annual General Body Meeting of the Society was held at the Central College, on November 25, 1939. The following were elected members of the Managing Committee for the year 1940:—Dr. B. Sanjiva Rao (*President*), Dr. K. S. Gururaja Doss (*Treasurer*), Dr. M. N. Ramaswamy (*Secretary*), Mr. H. S. Venkataramiah (*Joint Secretary*), Mr. B. H. Iyer, Mr. B. H. Krishna, Dr. P. Krishna Rao, Prof. L. Rama Rao, Dr. S. Subba Rao and Prof. A. V. Telang.

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The Ninth Annual Session of the **National Academy of Sciences** was held at Allahabad on 13–14 January 1940. H.E. Sir Maurice Hallett, the Governor of the United Provinces, who is the patron of the Academy, inaugurated the session.

Sir Shah Mohumud Sulaiman was re-elected President for the year 1940.

The Education Minister's Gold Medal was awarded to Dr. Mohammad Abdul Tamid Siddiqui, Professor of Anatomy, King George's Medical College, Lucknow, in consideration of his paper on "Geneto-urinary System of the Indian Ground Squirrel".

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Mr. J. B. Ross was elected President of the **Mining, Geological and Metallurgical Institute of India** for 1939–40 at the annual general meeting of the Institute held at Calcutta on January 12. Mr. J. J. Ghandy, Mr. E. S. Pinfold and Rao Bahadur D. D. Thacker were elected Vice-

Presidents and Dr. A. L. Coulson, Honorary Secretary.

The Government of India Prize of Rs. 500 was awarded to Mr. A. Wilson Haig for his paper on "Coal Carbonization and some of Its By-Products".

* * *

National Institute of Sciences of India.—At the annual meeting of the Institute held at Madras on 2nd January, Bret.-Colonel R. N. Chopra, C.I.E., M.A., SC.D., F.R.C.P., Director, School of Tropical Medicine, Calcutta, was re-elected President of the Institute for the year 1940. Sir U. N. Brahmachari and Dr. A. M. Heron were elected Vice-Presidents. The other Office-bearers are Dr. B. S. Guha (*Treasurer*), Prof. Dr. J. C. Ghosh (*Foreign Secretary*) and Proof. S. P. Agharkar and Dr. C. S. Fox (*Secretaries*).

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University of Mysore.—I. EXAMINATIONS: The list of candidates who were successful at the S.S.L.C. Supplementary Examination held in November 1939 and declared eligible for admission to University Courses was published.

II. LECTURES: The following lectures were delivered:—(i) *University Extension Lectures*—(1) Mr. C. K. Venkataramayya, M.A., LL.B., Kannada Translator to the Government of Mysore, on "Poet Kumaravyasa" *in Kannada* at Chitaldrug. (2) Mr. A. R. Wadia, B.A. (Cantab.), BAR-AT-LAW, Professor of Philosophy, Maharaja's College, Mysore, on "The Problems of Industrial Civilization" *in English*, at Robertsonpet. (3) Mr. K. Sundaresan, L.M.S., Assistant Surgeon, Minto Ophthalmic Hospital, Bangalore, on "The Causes of Blindness", *in Kannada* at Davangere, and on "The Prevention of Blindness", at Chitaldrug. (4) Sri. B. Indiramma, M.A., DIP. EDN. (Leeds), Superintendent, Maharani's Women's Training College, Mysore, on "The need for a Knowledge of Child Psychology on the part of Parents", *in Kannada*, at Chickballapur and Chickmagalur. (5) Dr. A. Appadhorai, M.A., PH.D., Loyola College, Madras, on "The Revision of Democracy", *in English*, at Mysore. (6) Dr. Kavoor T. Behnan, B.A., B.D., PH.D., Department of Psychology, Yale University, on "Yoga—A Way of Life", *in English*, at Mysore, and on "Scientific Analysis of Social Phenomena", *in English*, at Bangalore. (ii) *Special Lectures*—Dr. M. V. Gopalaswami, B.A., B.SC., PH.D., Professor of Psychology and Logic, Maharaja's College, Mysore, on "The Nature-Nurture Problem in relation to Intelligence", *in English*, at Mysore.

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Announcements

Indian Science Congress, 1941.—The Twenty-eighth Session of the Indian Science Congress will be held at Benares from 2nd to 8th January 1941.

Sir Ardeshir Dalal, Managing Director of Messrs. Tata Iron & Steel Co., Ltd., has been elected General President of the Congress. The following have been elected Sectional Presidents:—Prof. K. Ananda Rao (*Mathematics and Statistics*), Prof. P. N. Ghosh (*Physics*), Dr. Mataprasad (*Chemistry*), Dr. M. R. Sahni (*Geology*), Dr. S. M. Tahir Rizvi (*Geography and Geodesy*), Dr. Sri Ranjan (*Botany*), Dr. A. Subba Rao (*Zoology*), Rao Sahib Y. Ramachandra Rao (*Entomology*), Mr. T. C. Das (*Anthropology*), Mr. A. C. Ukil (*Medical and Veterinary Research*), Mr. K. Ramiah (*Agriculture*), Dr. B. B. Dikshit (*Physiology*), Dr. I. Latiff (*Phychology and Educational Science*) and Sir M. Visvesvaraya (*Engineering*).

The Editorial Committee of the **Imperial Council of Agricultural Research** announce that, with effect from January 1940, a new monthly magazine entitled "*Indian Farming*" will be issued in place of the bi-monthly "*Agriculture and Livestock in India*".

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We acknowledge with thanks receipt of the following:—

"Agricultural Gazette of New South Wales," Vol. 50, Pt. 12.

"Agriculture and Live-Stock in India," Vol. 9, Pt. 6.

"The Philippine Agriculturist," Vol. 28, No. 7.

"Monthly Bulletin of Agricultural Science & Practice," Vol. 30, No. 10.

"Biochemical Journal," Vol. 33, No. 10.

"Journal of the Institute of Brewing," Vol. 45, Nos. 7 and 11.

"Journal of the Indian Botanical Society," Vol. 18, No. 3.

"Biological Reviews," Vol. 14, No. 4.

"Journal of the Indian Chemical Society," Vol. 16, No. 10.

"Journal de Chimie Physique," Vol. 36, Nos. 7–9.

"Comptes Rendus (Doklady)," Vol. 24, Nos. 6–8.

"Experiment Station Record," Vol. 81, No. 5.

"Indian Forester," Vol. 66, No. 1.

"Review of Applied Mycology," Vol. 18, No. 11.

"Calcutta Medical Journal," Vol. 36, Nos. 5–6.

"Bulletin of the American Meteorological Society," Vol. 20, Nos. 8–9.

"Scripta Mathematica," Vol. 6, No. 2.

"Indian Medical Gazette," Vol. 74, No. 12.

"Indian Journal of Medical Research," Vol. 27, No. 2 (October 1939).

"Nature," Vol. 144, Nos. 3654–57.

"Journal of Nutrition," Vol. 18, Nos. 2–5.

"Journal of the Bombay Natural History Society," Vol. 41, No. 2.

"Proceedings of the Royal Society of Edinburgh," Vol. 59, Part 2.

"Canadian Journal of Research," Vol. 17, No. 11.

"Journal of the Royal Society of Arts," Vol. 87, Nos. 4539–40.

"Indian Trade Journal," Vol. 135, Nos. 1747–49, and Vol. 136, No. 1750.

ACADEMIES AND SOCIETIES

Indian Academy of Sciences:

December 1939. SECTION A.—B. SANJIVA RAO: *Studies in the Chemical Behaviour of Sulphur Compounds. Part I. The Hydrolysis of Sulphur Chloride.* The hydrolysis has been carried out at the interface between very dilute solutions of S_2Cl_2 in CCl_4 and aqeous alkali in the presence of cadmium hydroxide. The products are free sulphur, sulphide, sulphite and thiosulphite. The results can most satisfactorily be explained on the basis that disulphur oxide is the primary product of hydrolysis. B. D. SAKSENA: *Raman and Infra-red Spectra of Cyclopropane.* Assuming that cyclopropane molecule has a structure in which the carbons form a regular triangle and the hydrogens lie at tetrahedral corners out of the plane of carbon ring (symmetry group D_{3h}) the normal modes of vibration and the force constants have been calculated. The results are in good agreement with observations. S. S. BHATNAGAR, P. L. KAPUR AND G. KAUR (MISS): *Photopolymerisation of Anthracene in Benzene Solution from the Magnetic Standpoint.* The value of λ, the constitution corection factor for the bridged four-membered ring, has been determined by a magnetic study of the products of this photo-polymerisation. N. ANANTHANARAYANAN: *Diffraction of Light by a thin Metallic Half-plane.* The Fresnol diffraction patterns obtained with thin uniform metallic films having edges of razor-like sharpness, are characterized by a large number of fringes with high visibility on the darker side of the pattern. The changes in these patterns with increasing thickness of the film and also with wave-length of incident light are described and theoretically accounted for. B. SANJIVA RAO: *Studies in the Chemical Behaviour of Sulphur Compounds. Part II. Disulphur Oxide.* When the products of combustion of sulphur in oxygen under highly reduced pressure are passed into cold carbon tetrachloride, disulphur oxide S_2O is produced. This exists in the form of a stable complex with S_8.

December 1939. SECTION B.—G. VENKATARAMAN: *A systematic account of some South Indian Diatoms.* The diatoms described comprise the collections made by several workers —Prof. M. O. P. Iyengar, Dr. T. Ekambaram, Prof. R. Gopala Iyer, Dr. B. Sundararaj and the author. 98 Forms representing 33 genera are described. Of these, 67 are new records for India, 3 are new species, 6 new varieties and 6 new forms. HAMID KHAN: *Study in Diseases of Fish: Fin-Rot—A Bacterial Disease of Fins of Fish.* A rod-shaped bacterium present in large number in the infected tissues, has been incriminated as the causative agent for the finrot disease. Copper sulphate solution (1-20,000) bath for 10–15 minutes, has been found to cure the fry in early stages of the disease. It has not been found possible to cure the fish in advanced stages of the disease.

Indian Chemical Society:

October 1939.—JATINDRA CHANDRA PAL AND B. C. GUHA: *Combined ascorbic acid in plant foodstuffs—Part I.* PRATUL NATH SENGUPTA AND B. C. GUHA: *Combined ascorbic acid in plant foodstuffs—Part II.* BAIDYANATH GHOSH AND B. C. GUHA: *Concentration of ascorbigen from cabbage.* K. C. SAHA: *Distribution of free and total ascorbic acid in the liver and muscle of Bengal fresh-water fish.* PHULDEO SAHAY VARMA, K. S. VENKAT RAMAN AND (MISS) K. M. YASHODA: *Condensation of asrenic chloride with dialkyl aromatic amines.* SHARIFUDDIN WARSI AND SALIMUZZAMAN SIDDIQUI: *The constituents of* Didymocarpus pedicellata. *Part IV. Isolation of two new colouring matters and their relationship to pedicin.* MUHAMMAD QUDRAT-I-KHUDA AND AMALENDU KUMAR RAY: *Chemistry of spiro-compounds. Part I. Preparation of cyclopentane spiro-cyclopentanone and cycloHexane-spiro-cyclo-heptanone.* MUHAMMAD QUDRAT-I-KHUDA AND ASUTOSH MUKHERJEE: *Chemistry of spiro-compounds. Part II. Synthesis of cyclopentane-spiro-cyclopentanone.* M. S. TELANG AND V. V. NADKARNY: *Kinetics of the reaction between potassium persulphate and the alkyl iodides. Part I. Influence of solvents, acids and salts.* K. P. BASU AND K. GUPTA: *Biological value of the proteins of some species of Bengal fish by the nitrogen balance and growth methods.* PRATUL NATH SEN-GUPTA AND B. C. GUHA: *The estimation of Vitamin C in foodstuffs.* M. P. SHAH AND V. B. THOSAR: *A note on the action on nitrosyl chloride on monobromomalonamides.*

South Indian Science Association, Bangalore:

August 30, 1939.—K. S. GURURAJA DOSS: *A New method of determining the cross-section of molecules.*

November 21, 1939.—SIR C. V. RAMAN: *Prof. Lawrence and the Cyclotron.*

December 14, 1939.—N. V. RAGHUNATH: *Ceramic Industry in India.*

Indian Botanical Society:

November 1939.—EDWARD BARNES: *The species of Geraniaceæ occurring on the Travancore High Range including the description of a new Balsam.* B. N. SINGH, S. SAMPATH AND R. K. BANSAL: *A new fixative for plant smears.* P. N. GHATAK AND T. C. ROY: *Studies in the soil fungi of the paddy-fields of Bengal. I. Fungi of an unmatured paddy-field of the Chinsura Agricultural Farm.* D CHATTERJEE: *Some dominant plants of India.*

SUPPLEMENT TO CURRENT SCIENCE

Vol. IX] INDIAN SCIENCE CONGRESS, MADRAS, 1940 [No. 1

PRESIDENTIAL ADDRESS

Congress President:

PROFESSOR B. SAHNI, M.A., Sc.D., D.Sc., F.N.I., F.R.S.

THE DECCAN TRAPS: AN EPISODE OF THE TERTIARY ERA

The Eocene Age: A 'Dawn of the New'

LESS than six months ago the British Association for the Advancement of Science met under the presidentship of a renowned scientist. In his address at Dundee, Sir Albert Seward gave a vivid account of the way in which, by a study of fragments, such as samples of rocks and of the remains of plants preserved in them as fossils, he was able to visualize a scene in the west of Scotland at the dawn of the Tertiary era. As a pupil I feel tempted to follow his example, and to attempt a reconstruction of an Indian scene at about the same period of the earth's history.

But I would ask you to bear with me if I seem at times to be telling a fairy tale. For at this distance of time we can only see a dim outline of the world as it was, and the exact language of science is ill-suited to the description of visions.

Competent authorities place the dawn of the Tertiary era between sixty and seventy million years ago. It is the birth of a new era in a very real sense. Stupendous forces, surging in the womb of the earth, had already caused gigantic rifts in the crust, and these rifts are gaping out into oceans. From smaller fissures in the crust, molten rock is now pouring forth in repeated floods of lava which will cover millions of square miles of land and sea. Vast areas are being converted into desert by showers of volcanic ash. A new type of landscape develops, with high volcanic plateaus as a dominant feature. The face of the earth is rapidly changing. She puts on a more modern garb of vegetation; the land, lakes and rivers become peopled by creatures more familiar to us. Still there is no sign of man. But the stage is being set for his arrival. For this critical period foreshadows the birth, out of the sea, of the mightiest mountains of the world; and the heaving bosom of the earth, somewhere to the north of India, is to be the cradle of man.

Such was the Eocene age: it was literally a 'dawn of the new'.

Early History of the Deccan

To arrive at our early Tertiary scene in India we can either work backwards from the present, or approach it from a still earlier past and try to appreciate the setting in which that scene was laid. I prefer the latter course, although for a few moments it will take us far behind the period with which we are specially concerned. For we shall have to go back to a time, at least three hundred million years ago, when neither the Atlantic nor the Indian Oceans were yet born.

Opinion is by no means agreed even upon the broad distribution of land and sea prior to the Tertiary era. But according to a theory now generally associated with the name of Professor Wegener, who died a hero's death in Greenland a few years ago in the pursuit of Science, all the land areas of the globe were once directly united together into one world continent. The two Americas lay much further to the east, while Europe and Africa lay further west, than at present. Greenland, Iceland and the British Isles were all much closer together and were wedged in between Canada and Scandinavia. South America fitted into the great angle in the west coast of the African continent. Australia and Antarctica lay close up against the south-eastern coast of Africa, with the southern tip of India in contact with Madagascar and wedged in between the African and Australian blocks. At this remote period the South Pole was somewhere in Cape Colony.

At intervals during a period of several hundred millions of years disruptive forces of unthinkable magnitude have caused ever-widening fissures in the crust. The Great

Rift Valley of Africa is believed to be one of the youngest of these fissures, still in the making. The Red Sea rift has now become two hundred miles wide; the Atlantic rift is already an ocean. And thus, like icebergs breaking off by the formation of crevasses from the snout of a glacier, or from the edge of an ice-sheet that has spread out to sea, the continental blocks are supposed to have drifted away into their present positions. But these continental movements have not been all movements of separation. They have also brought into contact with each other land blocks formerly sundered by the ocean.

Here, in Madras, we stand at the eastern edge of one of these blocks which, according to Wegener, has drifted—and perhaps is still drifting—north-eastwards from its former position in the southern hemisphere. To the north of it formerly lay the great Tethys Sea which once separated it from the main Asiatic mass. The Asiatic block, in turn, has moved south-west, towards India. As the two great land masses approached each other, narrowing down the width of the intervening sea, parts of the ocean floor were caught up as between the jaws of a gigantic vice, and they have been squeezed, crumpled and uplifted into the chain of the Himalayas.

A Primeval Landscape

By far the greater part of the Indian peninsula is made up of rocks that have solidified from a molten state. But the igneous activity which these rocks indicate took place in distinct periods separated from each other by a span of time of which no adequate estimate is yet possible.

The eastern and southern portion of the peninsula (shown red in geological maps) forms one of the most ancient land surfaces of the globe. Parts of it are believed to belong to the primeval crust of our planet as it first cooled and condensed from a gaseous or liquid mass.

From time to time other molten rocks from the interior have burst through this crust and solidified in the cracks, forming thick sheets or walls cutting across the older rocks. The early convulsions of the earth while she was young are still recorded in the complex folds into which these archaic rocks have been thrown. Over large areas the original rocks have been fractured by earth movements or so badly crushed and altered that we can no longer tell their mode of origin.

This was the kind of primitive landscape on which, long afterwards, life first originated (in water) and on which the stratified crust of the earth was laid down. With the passage of time the greater part of this crust has worn away, and the old surface has again been laid bare. But portions of the strata still remain, protected in deep trough-like hollows in the old river basins, the Mahanadi, the Godavari and the Narbada, and in a string of outlying patches along the east coast, from Trichinopoly as far as Cuttack. These deposits were laid down chiefly in lakes and rivers, but partly also in shallow seas that flooded the land from the north and east. The wealth of evidence these strata contain tells of great changes of climate and of a long succession of floras and faunas that lived on the vast southern continent of which India once formed an integral part.

Except for these temporary incursions of the sea the plateau of the Deccan has remained a land area, so far as we know, ever since the original crust was formed.

We have seen that the eastern and southern parts of the peninsula are composed mostly of rocks of great antiquity. Similar rocks, in fact, form the foundations of all the continental blocks, the eroded tops of the ancient mountains often projecting through rocks of more recent date. The Nilgiris, and the Palni and Annamalai Hills, are composed of large dome-like masses of semi-molten rock which have heaved up the overlying crust and have later been exposed by the denuding action of rain and rivers. These primeval hills usually have rounded, undulating outlines. Occasionally an isolated dome rises suddenly out of the alluvial plain. There it stands, like a petrified sentinel of the hoary past, with his face obliterated and his feet buried in the dust of ages.

Through untold æons of Time Nature has carved this ancient surface into fantastic shapes. Great masses of rock sometimes lie uneasily perched one on top of another in threatening piles, like dilapidated towers. Vast areas are strewn with enormous weathered blocks lying in utter confusion, as if a great city, where only giants must have lived, had been laid in ruins. Occasionally a huge sphere of granite lies precariously poised on the rounded back of a hill as if one could, with a mere push, send it hurtling down the hill-side. A later day has seen the handiwork of man superimposed upon Nature's in sculptured epics like those at Mahabalipuram—unsurpassed in the

grandeur of their conception or in the depth of devotion that inspired them.

The Deccan Trap Country

Very different is the landscape in the central and western parts of the Deccan, coloured green, by convention, in all geological maps. This is much younger ground, for as we step over from the red part of the map to the green we traverse, at a single bound, a vast span of geological time: in most places the newer rocks rest directly upon the eroded surface of the old foundations. Abruptly we are transported into a new era of the earth's history. In fact we have arrived at the dawn of the Tertiary. After a long period of quiescence the volcanic energy pent up in the interior of the earth is now bursting forth in floods of lava on a scale never witnessed before or since.

Delegates to this Congress who have travelled here from the north by way of Bombay or Nagpur must have noticed the long, low, flat-topped hills which dominate the scenery over the greater part of the country drained by the Narbada and Tapti and by the upper reaches of the Godavari and Krishna rivers. The same type of scenery extends into Kathiawar and Cutch, and for at least two hundred miles north of the Narbada. Crossing the Western Ghats from Bombay to Poona the railway climbs up through gorges cut through a series of terraces at different levels, like the remnants of a gigantic staircase. These terraces are the exposed surfaces of successive sheets of lava which were poured out at intervals, during a period that must have extended through many thousands of years, and which on the west coast were piled up to a thickness of 6–10 thousand feet.

The Deccan before the Eruptive Period

With the fragmentary data at hand let us try to picture the geography of the Deccan during the Cretaceous epoch which preceded this era of fire and devastation. The south-east coast is flooded by a shallow sea, teaming with life, from Trichinopoly as far as Pondicherry. The same sea stretches north-eastwards into what is now the Province of Assam, for similar types of fossil shells have been found in the two regions. Near Utatur we may pick up fossil timber, riddled with holes made by extinct types of wood-boring molluscs. The shells of the creatures still lie in their burrows, petrified within the wood: the logs must have drifted down an east-flowing river into an estuary or lagoon a hundred and fifty miles south of Madras.

The northern sea has also overflowed the land, in the region of the lower Narbada. But the fauna here is very different, because the barrier of the plateau cuts it off from the southern sea. The northern fauna is more allied to the European—in fact the same ocean stretches on one side into Europe and on the other as far as Tibet and China.

But of our western coast at this period there is no evidence; either India has not yet split away from Africa; or, what seems more likely, it has brought away with it a large tract of land which lies to the west. By the sinking of this tract the gulf between India and Africa will widen out into the Arabian Sea, isolating our triangular island of the Deccan which, like a gigantic raft that has been cut adrift, will continue on its long journey to the north-east.

Amongst the denizens of the land, dinosaurs abound in the forests of the Central Provinces. Many of them belong to types peculiar to India but, strangely enough, they have their nearest relatives among the dinosaurs of Madagascar and South America: there must still be some land connexion left that allowed these reptiles to intermigrate. But they are rapidly running out their race. The last of the Indian dinosaurs lie buried in the Lameta beds near Jabalpur and at the village of Pisdura near Warora, to the south-east of Wardha.

The Dawn of the Tertiary Era

We are now approaching the end of the Mesozoic era. The old southern continent is breaking up. The gulfs widen. The same sea that washes the northern shores of the Deccan receives the rivers that drain parts of Egypt, France, Belgium and England. It also laps the shores of Mexico in the far west. In the far east, it sweeps southwards, past Borneo. This is the equatorial ocean of the time, the birth-place of the great mountain ranges of the world in the era that is to come.

It is over such a scene as this that the Tertiary era dawns, with the lurid light of volcanic outbursts. There are, indeed, no volcanoes in the familiar, Vesuvian, sense. The lava wells up quietly through fissures in the earth. But these fissures are hundreds of yards wide and stretch for miles across the country, with crooked cracks branching off to right and left, all brimming with the fiery liquid. In the Rajpipla hills near Broach, in Cutch, Kathiawar and other parts of Western India, some of these old fissures

can still be recognized, with the lava solidified inside them in the form of walls or dykes.

The Deccan lavas, being rich in iron, are of a specially fluid kind that takes long to set. They flow almost like water, filling up hollows in the land and spreading rapidly in horizontal sheets, covering miles of country before they harden into the basalt or 'trap' rock that is familiar to us. In its devastating march the 'fiery deluge' bakes up the soil and consumes all surface vegetation. The very earth is on fire.

Pools and tarns begin to seethe as the lava flows over them. Here and there a stream is dammed up and collects its waters in a temporary lake till it finds or makes a new channel, or the lake itself is covered up by another eruption. The bigger rivers, not so easily blocked, manage to keep their old course, gradually cutting their way through any lava flows that might cross their path. But the eruptions continue from time to time, and from place to place over an enormous area, originally perhaps half a million square miles, from Rajahmundry to Cutch and from near Dharwar almost as far as Jhansi; piling sheet upon sheet of molten rock and loading the old foundations under a plateau thousands of feet thick. Even after the continuous erosion of millions of years the Deccan traps still cover an area of 200,000 square miles, and you can travel all the way from Nagpur to Bombay, a distance of five hundred miles, without ever stepping off the volcanic rocks. Their abrupt ending along the west coast, where they are thickest and form the great scarp of the Western Ghats, leaves us no real measure of their original extension into the tract of land that foundered into the Arabian Sea.

It is difficult to tell where, in the enormous area of the Deccan traps, this igneous activity first began. The traps of the Nagpur-Chhindwara region were certainly among the earliest to be poured out and, so far as we know at present, the highest flow of the series is to be seen on Malabar Hill and at Worli in Bombay. It appears the vulcanicity began in the eastern parts of the Deccan and gradually spread to the west.

The lava flows vary in thickness from a few feet to as much as a hundred. As one flow overlaps another, it seals up the old fissures, and any later eruptions have to force their way up through the entire pile. There is a tremendous outburst. A fresh crack has been rent open, or an old one has split wider. The yawning mouth of Hell roars with thunder, and hurls fire and smoke and ashes miles up into the sky, as if spitting curses on Heaven itself.

The ash comes down again, raining upon the lava still hot round the fissures, perhaps raising a mound here and there; or it extends the desolate waste by burying under its weight any fresh vegetation farther afield. Beds of volcanic ash abound in many parts of western India, specially round Poona and Mahabaleshwar. There must be an eruptive centre in the vicinity.

If a lake or river happens to be near by, the ash settles down on the water, forming a sort of volcanic sediment in which the creatures living there find a speedy grave.

But it is an immortal grave. For, through a process that is still largely a mystery to us, the bodies of these plants and animals become imperishably preserved. Particle for particle, cell for cell, the plant tissues are replaced by silica derived from the ash, or from a lava flow that may have overwhelmed the lake; and in the end we are left with an exact replica of the original in hard, indestructible silica.

This is not a mere cast or an impression of the external features of the plant, but a petrifaction in the strict sense, which you may cut into thin sections and of which you may examine under the microscope the minutest details of the anatomy. The preservation of the tissues is sometimes so perfect, and the resemblance with the tissues of modern plants is so complete, that while engrossed in their investigation in the laboratory we are apt to forget that we are dealing with forms of plant life that existed fifty or sixty million years ago.

Partly with the heat of the lava, but largely through the action of percolating minerals, the entire bed of the lake becomes hardened into a rock that rings under the hammer like a piece of steel. Embedded in the mud and silt are also the remains of any land plants, or the bones of animals living on the banks, that may have been carried down by a stream. Thus we may have a whole flora and fauna sealed up in a bed of volcanic ash, or in lake and river deposits interbedded between sheets of lava.

Life in the Deccan Trap Period

After what I have said it will be easy for you to picture the conditions in the Deccan trap period, and to realize how valuable for the historian of plant and animal life must be the documents preserved

in these intertrappean beds. They have their value, too, in the study of rocks, for the state of evolution of a flora or a fauna gives a measure of geological age more trustworthy than any yet discovered.

The age of the Deccan traps has now been a matter of discussion among geologists for over seventy years. The main point at issue was whether the volcanic period began during the decline of the Mesozoic era or at the dawn of the Tertiary. To most of you, the wranglings of geologists over the age of a stratum may seem rather futile and meaningless. But apart from its scientific interest, a precise knowledge of the positions of strata in the geological time scale is of value in the exploitation of the mineral wealth of the earth.

We shall revert a little later to the question of the age of the Deccan lavas, for on this question the flora of the intertrappean beds gives evidence which, I venture to believe, is decisive. First let us examine a few selected specimens from this remarkable museum of plant antiquities.

By far the greater part of our knowledge of this flora is based upon collections made in the Nagpur and Chhindwara districts. This is a fortunate fact because here, as we have seen, some of the lowest beds of the series are exposed. According to Sir L. Leigh Fermor these are the oldest beds in the whole series, so that if we could fix the age of the fossils preserved in them we should know when the volcanic activity began. From here we have a great variety of spores, seeds and fruits; abundant remains of water-ferns and other aquatic weeds; different species of the lowly fungus order, sometimes found within the tissues of other plants which they have reduced to decay, as well as numerous kinds of petrified timbers, including palm stems in bewildering variety and number. Associated with these plant remains are the relics of animals that lived at the same time: the shells of many types of freshwater snails, the scales and bones of different kinds of fish, the wings of insects, and the skeletons of many other creatures of land and water. All these relics lie buried in a common grave.

Some of the earliest plant collections were made about ninety to a hundred years ago, chiefly by Christian missionaries, medical men and military officers in the service of the East India Company. Among these men the name of Stephen Hislop will always stand out prominently. It is a pity that this valuable material was not described in Hislop's day, for some of his most interesting specimens, mentioned in his published letters, can no longer be traced. I owe to the kindness of Mr. W. N. Edwards of the British Museum the loan of what remains in London of the Hislop collection. The rapid sketch I am about to attempt is based partly on this material, but mostly on specimens collected in recent years by members of the Geological Survey of India, by Professor K. P. Rode, S. P. Agharkar and P. Parija, by Mr. V. N. Shukla and myself. In the investigation of this material several workers have taken part and it is a pleasure to acknowledge the assistance I have received from the late Professor B. P. Srivastava, Mr. H. S. Rao and Mr. K. N. Kaul.

The intertrappean plants of the important area near Rajahmundry, which must have lived in the brackish waters of an estuary, are being investigated by Professor L. Rama Rao and his associates at Bangalore. These Rajahmundry beds are also low down in the series, and the plants probably lived at about the same time as those of Nagpur-Chhindwara.

Among the commonest fossils in the Deccan beds are some extinct species of stoneworts known under the expressive name *Gyrogonites*, derived from their tiny spirally twisted fruits. The great majority of species of this genus, described from France, England and other countries, are of early Tertiary age, and it is interesting that some of these are identical with our Deccan forms.

Some microscopic branched filaments, no doubt belonging to fungi, are seen attached to reproductive organs of two different kinds. One form, with more or less spherical closed bodies of a dark colour, recalling the fruit bodies of modern mildews of the family Perisporiaceae, has been described as a new species, *Perisporiacites varians*. The other has flask-shaped bodies. and for this the genus *Palæosordaria* has been created. Very little is known of the fossil history of the Perisporiaceæ and Sordariaceæ, but the few previous records, whatever their worth, are all from rocks of Tertiary age. The Deccan fungi were discovered in certain lake-muds at Sausar, midway between Nagpur and Chhindwara.

In the same lake deposits were found, in great abundance, the remains of *Azolla*, a familiar genus of small floating water-ferns which even to-day cover stagnant pools in many parts of the world. The

extinct species from Sausar, which has been named *A. intertrappea*, is geologically the oldest known form of the genus: a striking example of the tenacity with which even highly specialized forms of life can persist through the ages. The preservation is so perfect that most of the details of the anatomy, specially of the reproductive bodies which are highly characteristic of the genus, have been studied. Some hollow spherical bodies, associated with the *Azolla*, no doubt belong to an unknown genus of water-ferns, probably related to the modern *Salvinia*; the provisional name *Massulites* has been given to them. The spongy mass of which the body is composed contains small spores embedded in it much in the same manner as in *Salvinia*. Among many types of free-lying spores seen in the same rocks are two which deserve special mention. They are of two very different sizes, but they resemble each other so much in certain peculiar features that they appear to be the mega-spores and microspores of one and the same species, most probably another water-fern. The interesting point about them is the close resemblance they show, both in their structure and in their mode of germination, to the two kinds of spores, large and small, of the rare genus *Regnellidium*, which to-day is confined to South America. So far as I know, the water-ferns are unknown from rocks older than the Tertiaries.

In the Hislop collection at the British Museum there are a number of seed-bearing cones; some of them were found embedded in volcanic ash. The new name *Takliostrobus* has been given to one of them after Takli, a suburb of Nagpur, where it was discovered. Another has been named *Indostrobus*; a third was referred to the old genus *Pityostrobus*. All these cones have peculiar features of their own but the fact that in all of them the scales bear a pair of elongated seeds on the upper surface indicates that they were distantly related to our modern pines and deodars.

Of the several kinds of seeds found at Sausar, there is one intriguing type, *Sausarospermum*, remarkable for its several antique features. It recalls the seeds of certain fern-like plants from the coal measures of Europe, but it is hardly conceivable that there is any real affinity between them; at present it is best to reserve opinion on this matter. The name *Viracarpon* has been given to a cylindrical fruit, derived from a number of small flowers densely crowded on a thick axis. This is from the Hislop collection and it may be the very specimen which he mentions in his writings as a mulberry-like fruit, though unfortunately he never described it. The resemblance to a mulberry is purely superficial, for each flower produced a group of six seeds. It is impossible to say anything yet about the affinities, except that the nearest resemblance that I have so far been able to trace is with the fruits of certain palm-like plants of the family Cyclanthaceæ, now confined to tropical America.

A very interesting fruit, *Enigmocarpon*, was first discovered by Professor Rode near his home at Mohgaon Kalan, east of Chhindwara. The name is eloquent of our ignorance concerning its affinities, but the structure is perfectly preserved. It is an elliptical 8-chambered fruit about the size of a large pistachionut, with numerous dicotyledonous seeds in each chamber, attached on a central column from which the eight partitions radiate. The wall of the fruit is thick and spongy: the fruit was no doubt dispersed by water. To let out the ripe seeds the fruit wall bursts lengthwise, neatly, down the middle of each chamber.

Among Hislop's specimens are two species of cardamoms, both very like the small green kind that we commonly offer, with other spices, to guests in our homes. One of the specimens was so deceptive that a friend actually tried to peel it, till he discovered that it was petrified. In one broken specimen the seeds are exposed, showing their characteristic wrinkled surface.

The other monocotyledonous fruits all belong to palms: some have been described under the general name *Palmocarpon* which may include fruits belonging to widely different kinds of palms. One was named *Tricoccites* because of its supposed resemblance (which has proved deceptive) with the fruits of the Euphorbia family. It has three large chambers, each occupied by an equally large oblong seed. The fibrous fruit wall is thick and adapted for dispersal by water. It seems to have been divided up into a number of longitudinal chambers separated by partitions of hard tissue. The 'chambers' may have been quite empty, or filled with a loose spongy tissue which acted as a float. The surface was covered by a thin, smooth, water-tight rind. The whole fruit was about the size of a walnut, which it superficially resembled also in having a curious beak-like point.

But the most interesting of the Deccan palm fruits is one which Hislop writes he had found, but of which we have not been able to trace the original specimen. It is the fossil genus *Nipadites*, so called because of its resemblance with the fruit of the modern stemless palm *Nipa fruticans*, which forms dense clumps to-day in many tropical estuaries, and is common in the Sundarbans. Eighty years after Hislop's discovery was announced Professor Rode found another specimen at Mohgaon Kalan. This specimen shows all the characters of the modern genus, so we need have no hesitation in calling it a *Nipa*, although the species is different. The fruits of *Nipa* are by far the commonest fossils in the London Clay, which everybody agrees was deposited in the Eocene period; they have also been found in the Eocene of Belgium, and of the Paris basin, in fact, in the very grounds of the old Trocadero, now dismantled; also in the Mississippi basin, in southern Russia, in Egypt and in far-off Borneo. These fossil records of a brackish-water plant help us to draw at least roughly the coastline of the old Tethys sea, which must have swept the northern shores of the Deccan not far from where Chhindwara now stands. This important genus is scarcely known from rocks older than the Eocene.

It is interesting to see this evidence of brackish-water conditions in the Deccan supported by the fossil remains of aquatic animals. Dr. Hora describes several kinds of fossil scales belonging to types of fish which ordinarily inhabit fresh waters near the sea-shore but are capable of descending to the mouths of rivers. It is interesting, too, that on the whole the evidence of the fish-remains from the Deccan beds, first emphasized by Sir Arthur Smith Woodward over thirty years ago, and now confirmed by Dr. Hora, is in favour of an Eocene age; and Professor Bonnema wrote to me that the same is the case with the remains of some small crustaceans which show a treacherous resemblance to the seeds of plants.

But we must return to the palms, for these are by far the most important constituents of the intertrappean flora, and no doubt must have dominated the vegetation of those days. As a rule we only find bits of petrified stems which, for lack of a proper system of classification, we lump together under the artificial genus *Palmoxylon*; although among them there must certainly be many distinct genera that we could easily recognize, if we only knew the flowers or fruits. Sometimes we come across entire trunks, or large portions of them, with the thick mantle of roots still attached round the base. At the Nagpur museum there is a fine specimen, probably discovered at Saugor in Central India well over a hundred years ago; and in 1934 I was able to unearth from the dust and oblivion of the vaults of a Bombay museum a heap of petrified palm stems, some of which were certainly collected at Saugor before the year 1857. It is this very collection that H. J. Carter mentions in a paper of that date, but which had apparently been lost. Luckily, silicified plants do not deteriorate with age: they are immortal, as I have explained already; but alas, most of the labels are gone, except those that were painted on the specimens.

By their sheer number and amazing variety these palms of the volcanic period compel the attention of geologists, because from all accounts it appears that this family of plants, although it first arose in the Cretaceous period, did not rise to any prominence till after the Mesozoic era had begun.

The Age of the Deccan Lavas

I have tried to put before you, as briefly as I can, what we know to-day of the fossil flora of the north-eastern part of the Deccan. For deciding the question of the age of the Deccan traps it is perhaps unfortunate that so many of the plants are new to science and confined to this country; but, of course, they have an interest of their own. For the rest, you will have noticed that from what we know of the geological history of the stoneworts, the fungi, the water-ferns and particularly of the palms, which formed such a vast proportion of the flora, everything seems to point to a Tertiary age. What is more, the fishes and the crustaceans, too, seem to fall into line with the plants.

So much for the Nagpur-Chhindwara traps which, according to the geologists of the Indian Survey, are the oldest in the whole series. For all we know, the Chhindwara traps may have flowed out into an arm of the northern sea which was not far off. The lavas of the east coast, too, seem to be equally old. Professor Rama Rao and his colleagues, Messrs. Narayan Rao and Sripada Rao, have quite recently found stoneworts and other algæ of early Tertiary age in the estuarine beds of Rajahmundry, at the head of the Godavari delta.

It is curious that no intertrappean beds

at all have been discovered in the middle part of the series, which we cross as we travel towards the west coast. Not until we actually reach Bombay Island, where the highest members of the series are exposed, do we again come upon any sedimentary beds. It may be that during the middle part of the volcanic period the lavas were poured out in such rapid succession that no time was allowed for any plants or animals to colonize the desolate surface. Still, I think, a search ought to be made for traces of fossils along the planes between the lava flows, *e.g.*, at Matheran, Poona and elsewhere.

In the highest intertrappean beds, namely, those at Malabar Hill and Worli, plenty of organic remains have been collected, including a multitude of skeletons of a pigmy species of frogs. I have not seen any plants from here and cannot say whether these beds are much younger (geologically speaking) than those of the Central Provinces. But this seems to me unlikely, because we are told that near Surat and Broach the highest traps there are covered by marine beds of definitely known Eocene age. If this is true, then here, at least, the volcanic activity must have already come to a stop before the sea began to encroach upon the land in early Tertiary times. According to Professor V. S. Dubey the radio-active content of some of the traps in western India also indicates an early Tertiary age.

Thus the chances are that the whole of this imposing thickness of thousands of feet of igneous rock was poured out within the relatively short interval of the Eocene period. Quite probably this terrible drama of fire and thunder was only a brief episode of the very earliest part of the Eocene. The thickness of a stratum is by itself no measure of time. For after all it would not take long for a lava flow a hundred feet thick to be poured out like a flood from a fissure volcano, once it came to business. It is the deposition of the relatively thin sedimentary beds during the quiet intervals that must have taken up most of the time of the Deccan trap period.

The conclusion that the Deccan traps were poured out at the dawn of the Tertiary era and not at the close of the Mesozoic, brings them into line with other vast outpourings of Eocene lavas: for example, those that now cover at least 200,000 square miles of the north-western United States and the equally wide-spread lavas of the old Thulean continent that once united the western Isles of Scotland with Iceland, Greenland and other arctic lands.

Before I close I ought to say that this idea of the Tertiary age of the Deccan traps is by no means a new one. Indeed, it is over a hundred years old, for it was first put forward, so far as I know, by Malcolmson in 1837; and it was repeatedly expressed by Hislop and others in the middle of last century. In later years the question has been discussed and rediscussed by so many, and from so many different angles, that we could hardly see the wood for the trees. But the pioneers were right, as they so often are. They saw things more clearly because they worked with a clean slate and, as we all know, a clean slate is a very useful thing.

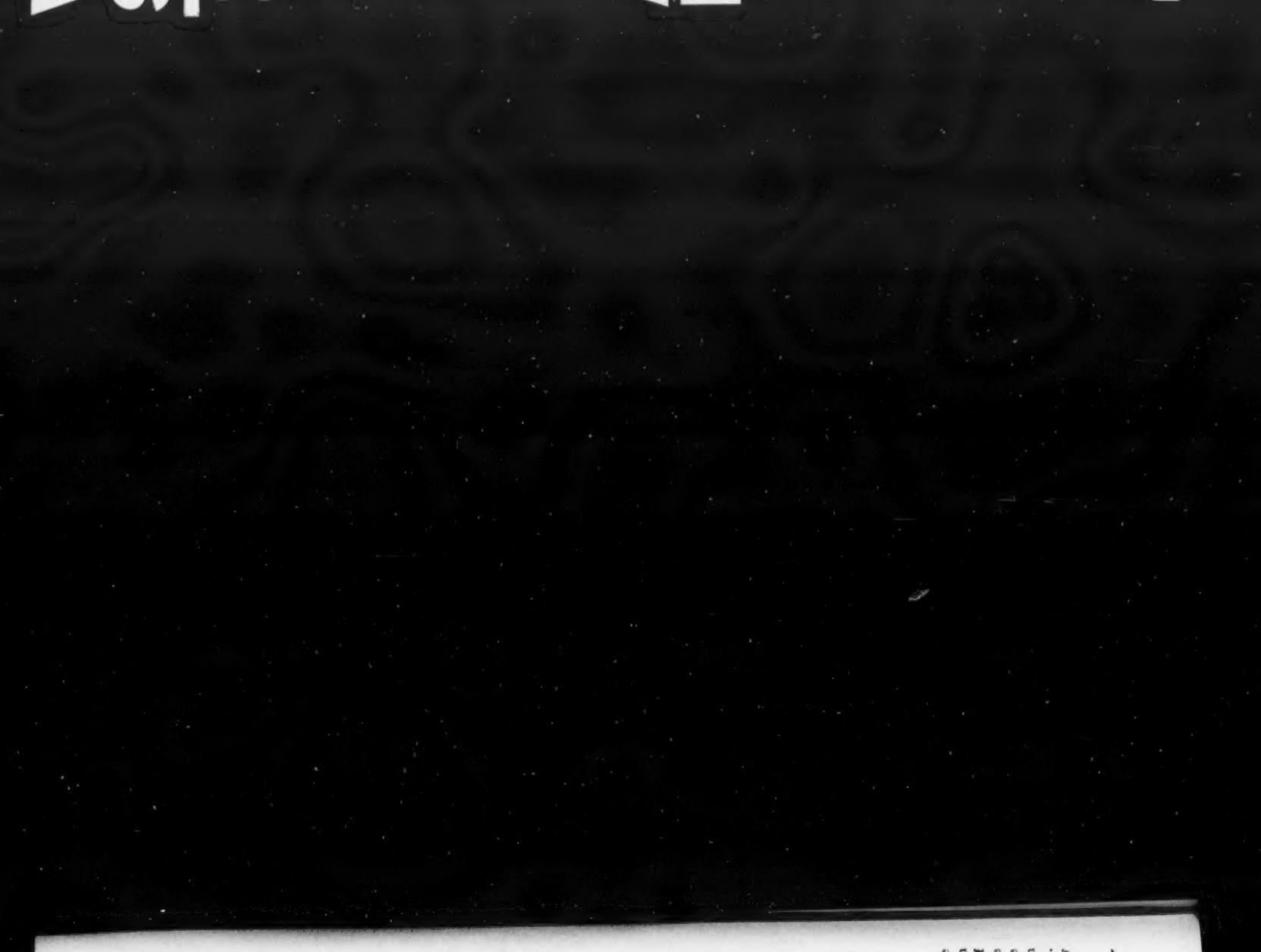
But the pioneer geologists were right also for another reason. They did not despise the mute but eloquent testimony of the plants that suffered the fiery ordeals of the dawn of the Tertiary era. For, as the first flashes from the fissure volcanoes flared up on the eastern horizon, the stalwart Palm said to the little *Azolla*:

> This lurid light is not a sunset glow—
> It is the herald of a morn.

And the fact is that this was the dawn of a new era: for, look at the number of Eocene genera of plants and animals that survive to this day.

Conclusion

We have now seen the contrast between the red part of the map and the green. Between the two lies a vista of time stretching back through well-nigh two thousand millions of years. But man, a recent creature of the earth, has united them in one poem of duty to his Creator: if the foundation rocks of the south have given us Mahabalipuram and the Seven Pagodas, the Deccan traps have given us Ajanta and Ellora.[1]

[1] In this popular presentation of the subject of the Deccan traps references to original sources have been purposely omitted. Those interested will find most of these works cited in an address delivered before the Botany Section of this Congress in January 1938, at the Jubilee Session held jointly with the British Association for the Advancement of Science (see *Proc. 25th Ind. Sci. Cong.*, 1938, Part II, pp. 33–76; reprinted as Lucknow University Studies No. II, pp. 1–100, 1938).

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